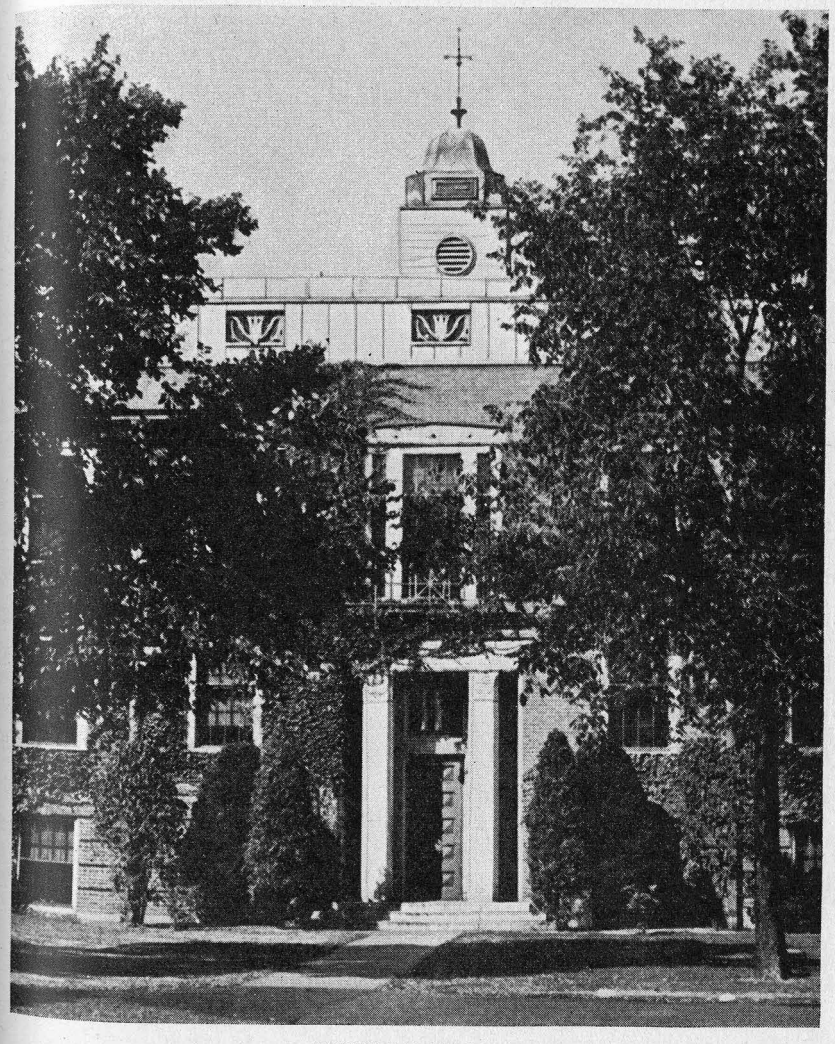
SCIENCE *Works* *for* AGRICULTURE



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.

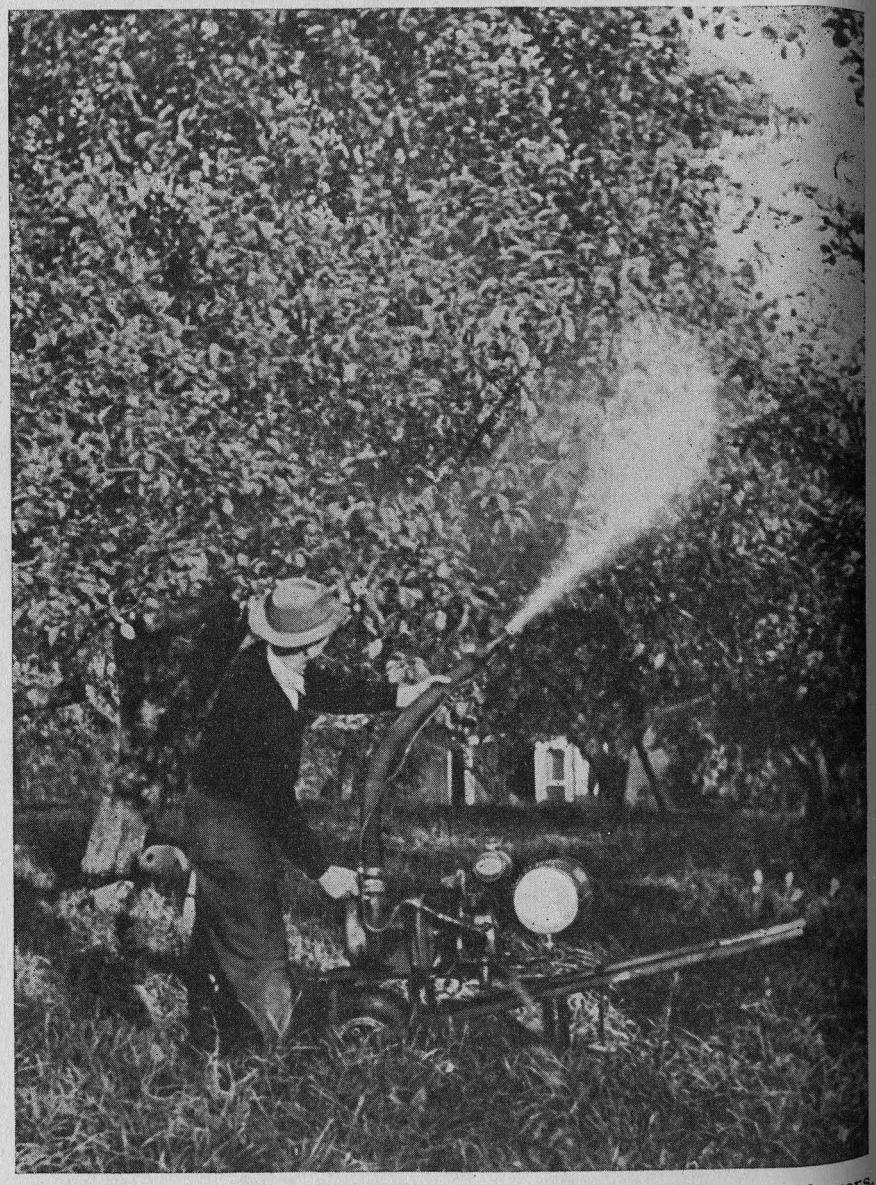
Although recent years have been especially difficult, for the Station, as for everyone, it is encouraging to find real progress has been made in service to Connecticut agriculture. After ten years of discouragement, a ray of light shines on the baffling problem of wireworm control in potato fields. Improved 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 86 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

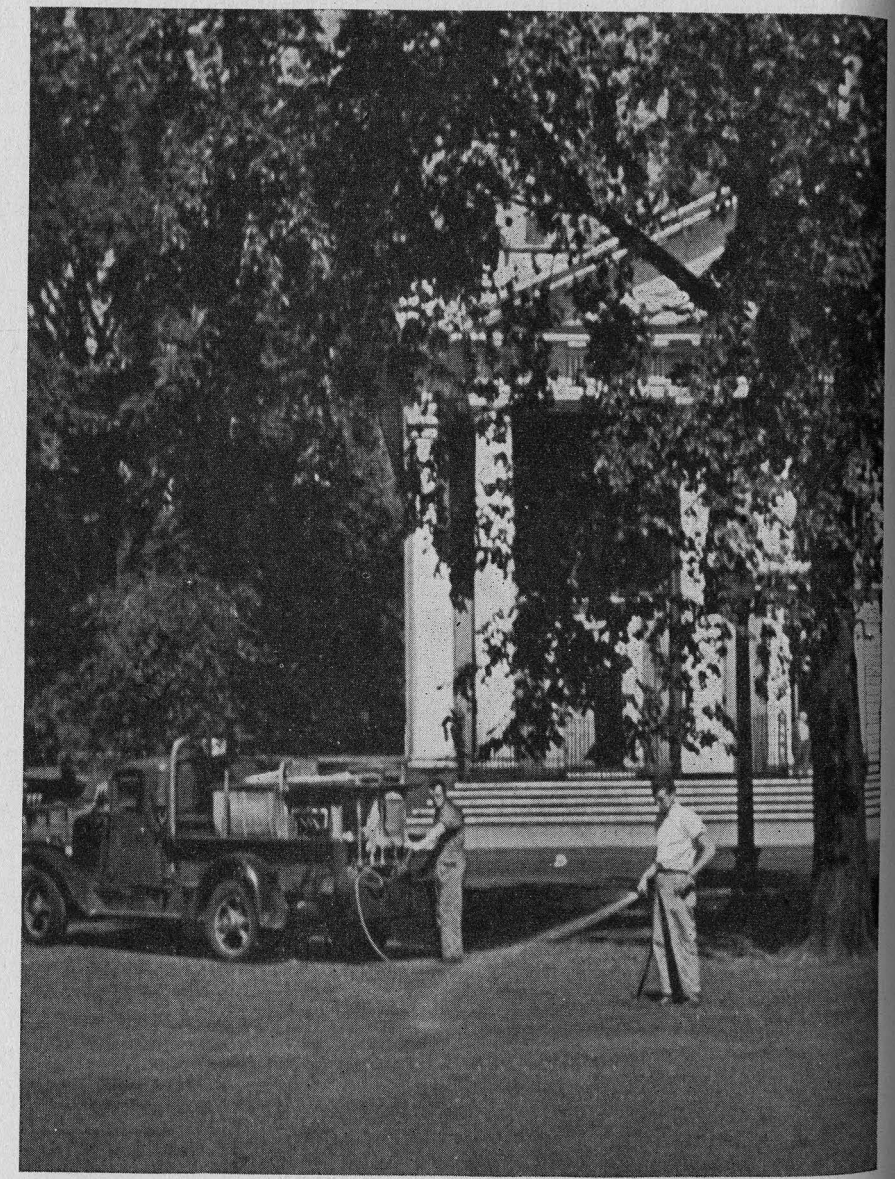
White pine blister rust control work in Connecticut has continued under cooperative agreement between the Connecticut Agricultural Experiment Station, the U. S. Bureau of Entomology and Plant Quarantine, and the State Agricultural Extension Service. The Station administers the program. There are approximately 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-

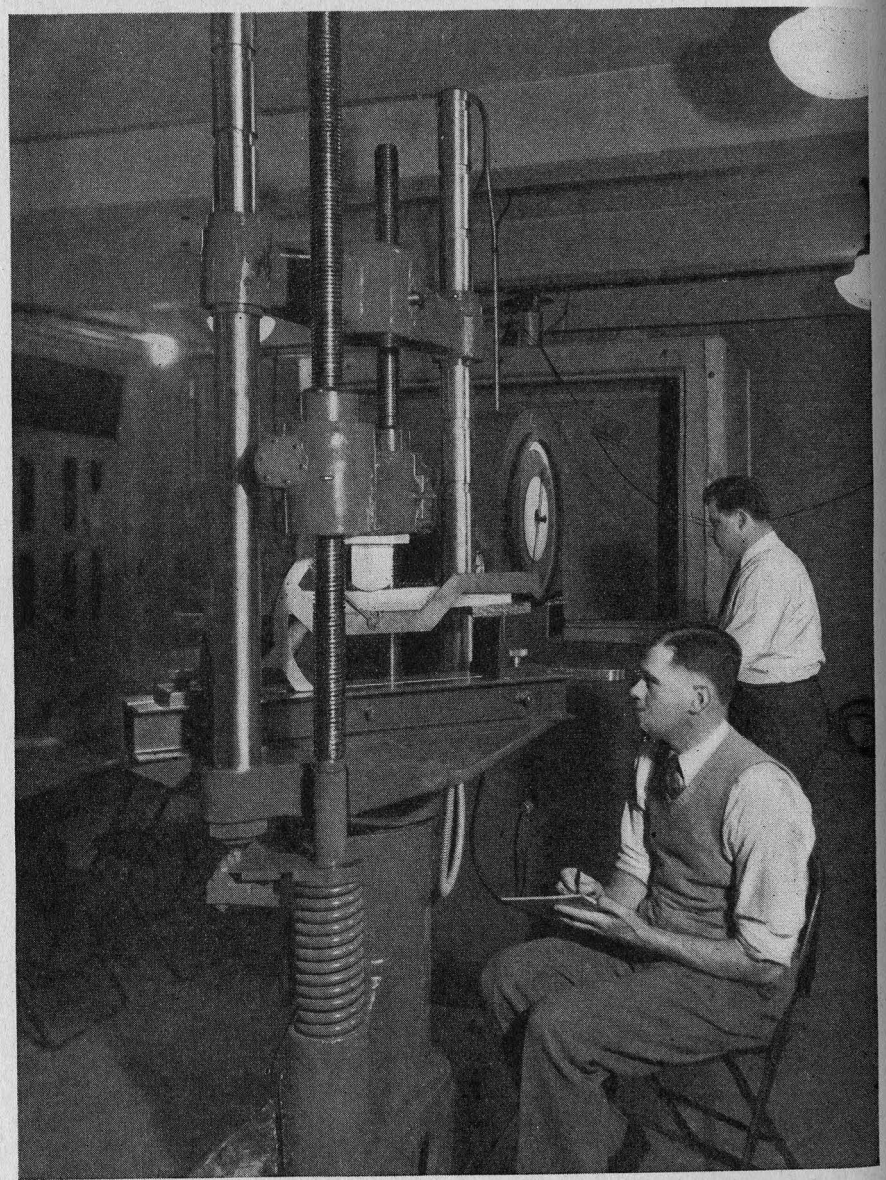
seed meal had been applied for 15 years previous to this experiment. This experiment has been designated as series "G."

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.

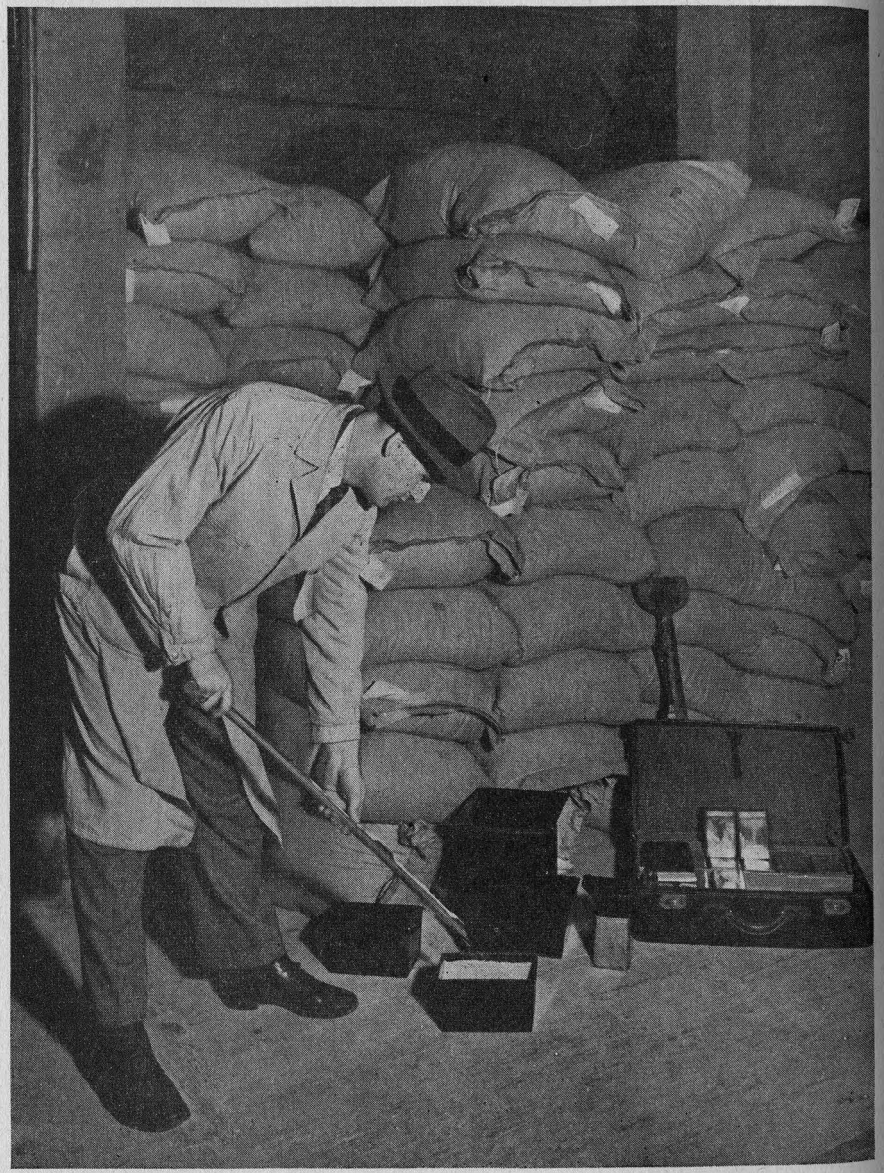
A series of experiments were also conducted, comparing ammonium nitrate with cottonseed meal as the sole source of nitrogen. Ammonium nitrate, used as the only supply of nitrogen and applied all at one time, gave results inferior to cottonseed meal. Even when applied in five fractional amounts at 10-day 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.

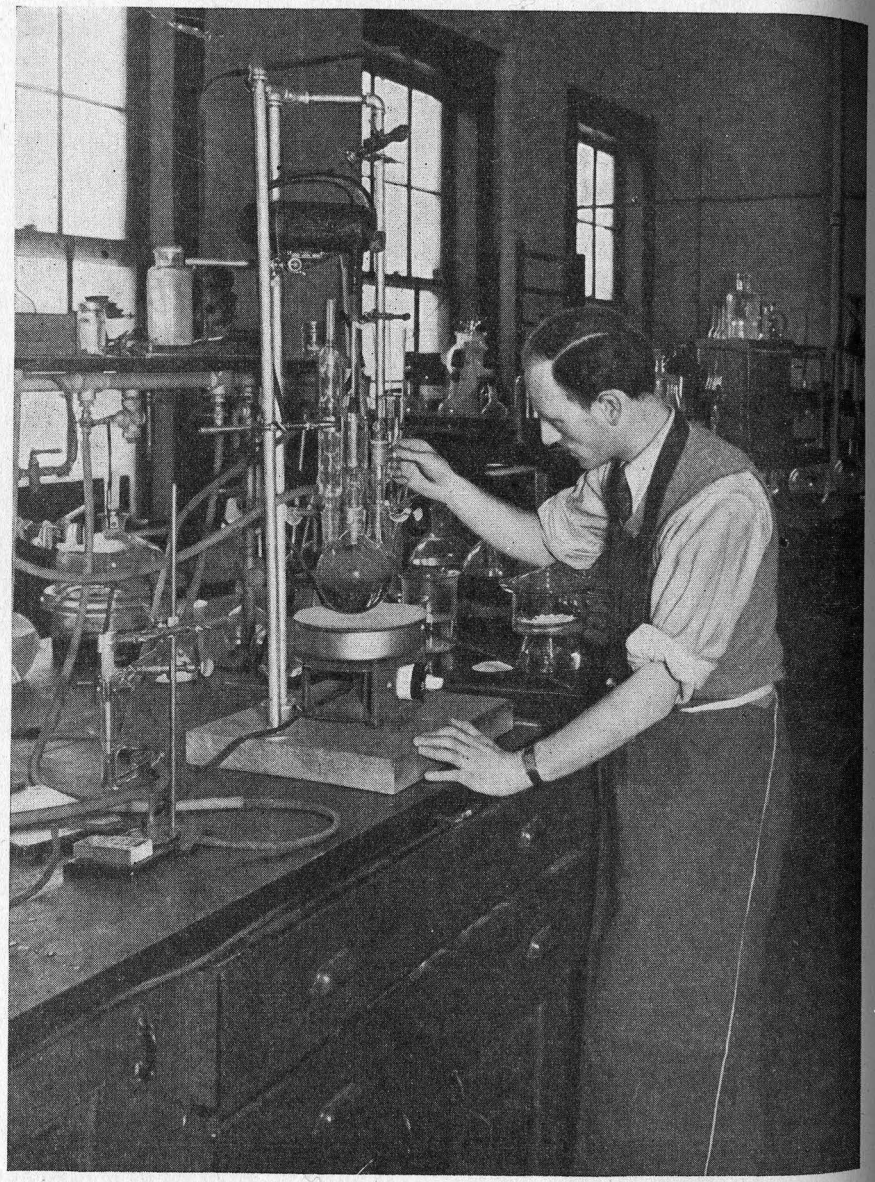
Studies have been made, and are continuing, of the use of the spectrograph in the determination of the mineral constituents of vegetable products and soils, of lead in spray residues, and of mercury, bismuth, antimony and other metals in biological specimens.

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.

Physiology of Fusarium Foot Rot Of Squash

George A. Gries

CONNECTICUT AGRICULTURAL
EXPERIMENT STATION
NEW HAVEN

Bulletin 500 — November, 1946

CONTENTS

PHYSIOLOGY OF FUSARIUM FOOT ROT OF SQUASH[1]

George A. Gries

Squash foot rot flared up so suddenly in the northeastern United States in the late 'thirties that it was alarming to growers. Knowing that root rot diseases in general are difficult to combat, everyone feared that squash growing in the area might be depressed to an uneconomic level. Research by several laboratories soon demonstrated methods of control that caused the disease to decline in destructiveness just as dramatically as it had risen. Now squash foot rot seldom occurs in Connecticut.

The first characterization of squash foot rot was published by Doidge and Kresfelder (1932) in South Africa. It was first reported in the United States from California by Snyder (1938) who worked extensively, not only upon the disease, but upon the taxonomy and morphology of the causal organism.

Foot rot of squash appeared in Connecticut and New York State at approximately the same time. The first published report of the occurrence of the disease in the East (New York) was that of Chupp (1939). When foot rot first appeared in Connecticut, the immediate need of practical information for combating the disease prompted Dr. Florence E. McCormick to undertake studies on the life history of the causal organism and the control of the disease. This work was continued by her until her retirement in 1941 when it was subsequently taken over by the present author.

There were two basic reasons for taking up the research on foot rot. First, it was a serious local disease on which information was needed and, secondly, it served as a segment in a larger research aimed at discovering additional basic information on root diseases in general. Experimental work had indicated that potato scab (Gries, Horsfall and Jacobson, 1944, and Schroeder and Albrecht, 1942) and club root of cabbage were influenced by the ratio of potassium and calcium in the soil independently of soil acidity relations. Squash foot rot proved to be a similar case.

The role of decomposing organic materials as a causative in non-parasitic plant diseases and as an influencing factor in parasitic diseases was another phase of the general root disease problem under study. Since it had been shown (Gries, 1942) that the by-products of rotting organic residues influenced the physiological functions of many parasites, this approach was also followed in the studies on the survival of the squash foot rot organism in the soil.

[1] The author wishes to express his thanks to Dr. James G. Horsfall for his valuable suggestions during the course of these investigations and for his assistance in the preparation of the manuscript.

SYMPTOMS AND CAUSE OF THE DISEASE

Symptoms on the Lower Stem

The first symptom of the disease in the field is a wilting of the leaves of the host plant similar to the wilting due to the bacterial wilt disease or to that attending a heavy infestation of the vine borer. Within a very few days, and frequently within a matter of hours after the first wilting is noticed, the entire upper portion of the plant collapses. Upon close examination of the basal part of the stem, a soft, sometimes mushy, area may be distinguished even before there is any change in color. As the disease progresses, the infected area becomes first a light and then dark brown as the parenchymatous tissues become completely destroyed. About this stage it is not at all uncommon to see a whitish or pinkish mass of fruiting mycelium of the fungus both on the rotted regions of the stem and on the surrounding soil. As the rot progresses, undoubtedly aided in part by other saprophytic fungi and bacteria, the tissue becomes drier until finally only the fibrous anastomosing strands of the vascular system remain.

The symptoms are similar on plants of any age, except that when plants are attacked in the seedling stage, the vascular system is also frequently destroyed, since it has not as yet become heavily lignified. The fungus does not usually affect the root system nor does it often progress far up the stem. The level on the stem at which the rotting occurs appears to be governed largely by the atmospheric and soil moisture, possibly as these two factors affect the aeration of the fungus' microclimate. Under conditions of very wet soil and high atmospheric humidity, the rotting may occur two to three inches above the soil line. Under dry soil conditions, however, the rotting is commonly below the soil level at a depth where the soil is in good tilth. Only this lower stem region or "foot" is commonly attacked. Hence, the name "foot rot".

An advanced stage of wilting as it appears on a mature plant is shown in Figure 1, while various stages of the disease are shown on the potted seedlings in Figure 2. The growth of the fungus on the surface of the soil surrounding a diseased stem is clearly shown in the latter illustration.

Symptoms on the Fruit

The fruit-rotting stage of the disease is not easily distinguished from the rots caused by many other fungi which gain entrance to the fruit from the soil. The first symptom to appear is a soft water-soaked area which later assumes a light brown color. As the fruit surface begins to dry out, there appear the characteristic white to gray zonate or radiating areas that are common to many fruit-rotting Fusaria. As these areas become more numerous, they may coalesce until finally the entire surface of the fruit may be covered. Following these initial lesions, the entire fruit, except for the skeleton, undergoes disintegration as a very soft watery rot. After this stage, with the cutinized surface apparently lacking or cracked, the fruit desiccates until only the dry shell remains.

The symptoms of the fruit-rotting stage of this disease as it occurs in the field may vary considerably from the above description since the over-all appearance of the rotting fruit depends not only on

Figure 1. Typical field symptoms produced by the foot rot Fusarium on a mature Early Prolific summer squash plant.

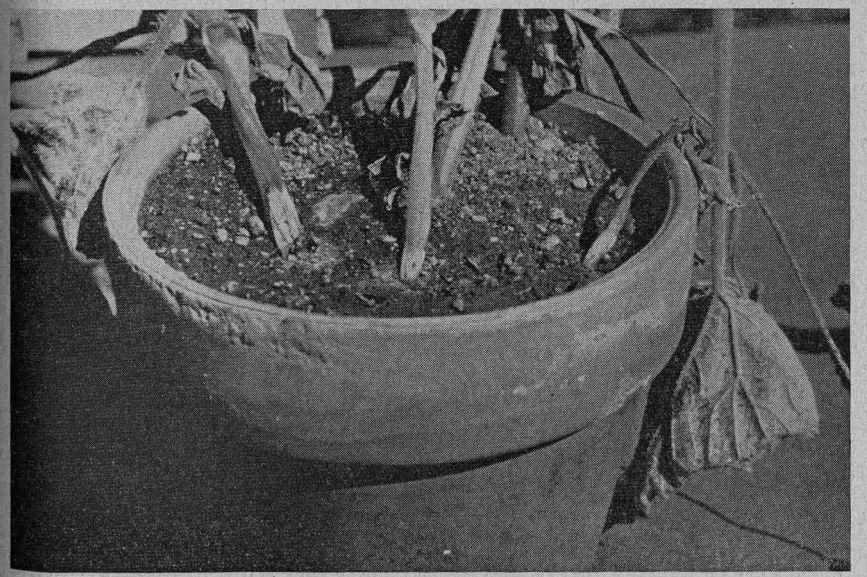


Figure 2. Foot rot symptoms on Early Prolific summer squash seedlings. Note the growth of the fungus on the soil surface around the base of the stems.

the foot rot fungus, but on the multitude of other fruit-rotting fungi and bacteria which are associated with the rot as it occurs in the field. Often in rotting fruits a yellowish vile-smelling slime develops as a result of the activity of certain common bacterial saprophytes.

The Causal Organism

In an effort to be consistent with the bulk of the literature published on this disease and its causal organism in the United States, the name *Fusarium solani*, f. *cucurbitae* has been used throughout this paper. This is the name proposed by Snyder and Hansen (1941).

THE HOST RANGE

Snyder (1938) reported the disease on *Cucurbita pepo*, *C. moschata*, and *C. maxima* and certain varieties of these species. He further noted that the Italian Zucchini squash is particularly susceptible. In Connecticut, the disease has been almost entirely limited to the yellow summer squash varieties (*C. pepo*), and to progeny of crosses involving this as one of the parents. A limited number of greenhouse inoculations have shown its host range to coincide with that listed by Snyder. No evidence of any resistance in the varieties of common summer squash has been noted.

TRANSMISSION AND INOCULATION

Seed Transmission

Almost as soon as the disease was observed in 1939, it was obvious that the fungus had entered the State on contaminated seed. It appeared throughout Connecticut and in nearby states the same year and attacked plants from certain seed lots and not from others. In some fields the diseased and healthy seed lots were side by side.

Examination of seeds soon showed the fungus to be present either as spores on the outside or as mycelium in the seed coat. In a few cases, we have observed it in the embryo of viable seeds, usually as mycelium, although occasionally the fungus when thus found is producing abundant spores. From these sources the fungus parasitizes the young plant growing from the infected or infested seed, girdling and rotting the young stem close to the soil surface. The fungus, once established in the soil from diseased seedlings, or from diseased non-viable seeds, may be spread in the field either mechanically through cultivation or by the growth of the fungus on organic debris in the soil. The spores of the fungus may also be spread by insects and by surface water.

Mechanism of Seed Contamination

The problem to be solved, of course, was the mechanism by which the seeds became contaminated. Inspection of stems on diseased

plants soon showed that the discoloration extends only a very short distance up the stem—never into the fruits. Clearly, then, the seeds do not become contaminated systemically through the pathway of the vascular elements. The evidence all points to the rotting fruit as the source of contamination. The seeds in rotted fruit may be actually penetrated by the mycelium or the seed may simply be coated with spores.

If this were the only source of contamination, the percentage of diseased seeds in commercial stocks would be small, because normally seeds would be saved only accidentally from diseased fruits. Probably, the greatest of all sources of contamination is the fermentation vat. Squash seeds are normally freed of pulp by a fermentation process. A few diseased fruits may supply sufficient inoculum to contaminate the entire vat of seeds.

The role of insects in the dissemination of the disease has been studied in detail only partially. Dr. Beard of this station showed that the squash bug (*Anasa tristis*) probably does not act as a vector of squash foot rot (Beard—unpublished data). Two other insects, the squash borer (*Melittia satyriniformis*) and the striped cucumber beetle (*Diabrotica vittata*) may possibly act as disseminating agents and should be studied from this angle. The injuries made on the vines by these two pests undoubtedly serve as infection courts for the fungus.

Efficacy of Seed Treatment

Some success has been attained in experiments in which the seeds have been treated with hot water to reduce the amount of infection. During the winter of 1943-44, samples were taken from a stock of heavily contaminated Early Prolific yellow straight-neck summer squash seed. These samples were hot water-treated over a wide range of time-temperature combinations from temperatures of 50°C. to 65°C. and at time intervals from five to 20 minutes at each temperature. The seeds were planted in uncontaminated soil in small flower pots to minimize the effect of the spread of the organism through the soil.

In Table 1 the results for three of the most effective time-temperature combinations and for the check are shown.

TABLE 1. EFFECT OF HOT WATER SEED TREATMENT ON THE EMERGENCE AND SURVIVAL OF SEEDLINGS OF EARLY PROLIFIC SUMMER SQUASH

Treatment	No. of seeds treated	No. of seedlings emerging	No. of diseased plants		Per cent survival of emerging seedlings	
			After 4 weeks	After 6 weeks	After 4 weeks	After 6 weeks
No treatment	200	111	111	111	0.00	0.00
55°C.–15 min.	200	42	7	9	83.33	78.57
60°C.– 5 min.	200	87	34	45	60.92	48.28
60°C.–10 min.	200	60	28	28	53.33	53.33

From the above table it is apparent that it is possible to reduce substantially the percentage of infection of the emerging seeds by

using the proper time-temperature values. This cannot be done, however, without sacrificing a relatively high percentage of viability. The percentage of infected viable seeds is probably lower than could be discerned from the data on emergence since many seedlings are frequently killed by the fungus between the time of actual germination of the seeds and the time they emerge through the soil.

Although the design of the experiment discussed above does not permit a distinction between surface-borne and imbedded contamination, other tests seem to indicate that surface-borne infection can be eliminated without a great reduction in the germination of the seeds. On the other hand, when surface-sterilized seed is used, the degree of reduction in the number of viable seeds closely parallels the number of seeds showing true seed infection in the seed coat or embryo. Thus, it would seem that the lethal time-temperature constants are very similar for the embryo of infected seeds and for the imbedded fungus tissue, if indeed it is not lower for the embryo.

Sterilization of the seed in 1-1000 bichloride of mercury for 15 minutes followed by thorough rinsing in water gave satisfactory results only when the seed infection was primarily of the surface-borne type as indicated by microscopic examination. It would thus seem that when it is absolutely essential to reduce the infection in a quantity of seed, the hot water treatment is preferable to a corrosive sublimate treatment or to a combination of the two.

The use of copper or organic seed protectants in combating surface-borne spores has not been studied in detail, but none of the materials tried has been effective in reducing penetration of healthy seedlings by the fungus in heavily contaminated soil.

Effect of Age of Seed

As is the case with most seed-borne plant diseases, squash foot rot is most easily and efficiently controlled by the use of disease-free seed from fields in which the disease has not been known. Since it is not possible to distinguish diseased seed without microscopic examination or a culturing procedure, seedsmen have found another method for insuring relatively clean seed. They have learned through experience that seed two or more years old when planted does not produced diseased seedlings. One explanation forwarded for this "cleaning-up" of the seed is that the fungus infection dies out. This hypothesis seems to be tenable for the surface-borne type of contamination, which probably does desiccate and lose its viability. A more probable explanation of the "self-sterilization" of those seeds in which the mycelium, alone or with spores, is in the seed coat or embryo is that the fungus itself destroys the germinating power of the seed, probably through the digestion of the embryo tissue. We have in several cases succeeded in culturing the fungus from samples of old seed which when planted did not give seedling infection. Apparently, the fungus-containing seeds do not germinate and the fungus present does not spread rapidly in the soil.

EFFECT OF TIME AND MANNER OF INOCULATION IN THE FIELD

Experiments have been conducted on the effect of time and position of inoculation on the amount of seed contamination. Inoculations were made by injecting one cubic centimeter of a spore suspension of the fungus (containing approximately 50,000 spores) into three parts of the fruit: pedicel, basal fleshy portion, and seed cavity. Inoculations were made at all positions at approximately five-day intervals between the date of flowering and the date of maturity. In nearly all experiments the fruits were left on the vine until they were mature (five to six weeks).

The seeds were fermented inside each of the inoculated fruits, washed, dried and stored over winter. The following summer, they were planted in disease-free soil. Three kinds of data were collected (Table 2): (1) number of fruits producing at least 5 per cent of normal seeds, (2) number of seedlings that failed to emerge as a result of the disease or other factors and, (3) number of emerged seedlings showing disease.

Assuming that the disease killed the seedlings that did not emerge, the total of the last two will give the total infection of the apparently normal seeds. Unfortunately, the total number of seeds set was not determined. From that number could have been determined the effect on seeds while they were still within the fruit.

In any event, two marked trends show in the data in Table 2. The percentage of disease in the seeds decreased with the age of the seeds and with the distance between the point of inoculation and the cavity where the seeds were borne.

The rate for these trends is interesting. The quantitative effect of distance is difficult to appraise because the errors are large. The distance from one side of a seed cavity to the other may be as great as the distance to the pedicel.

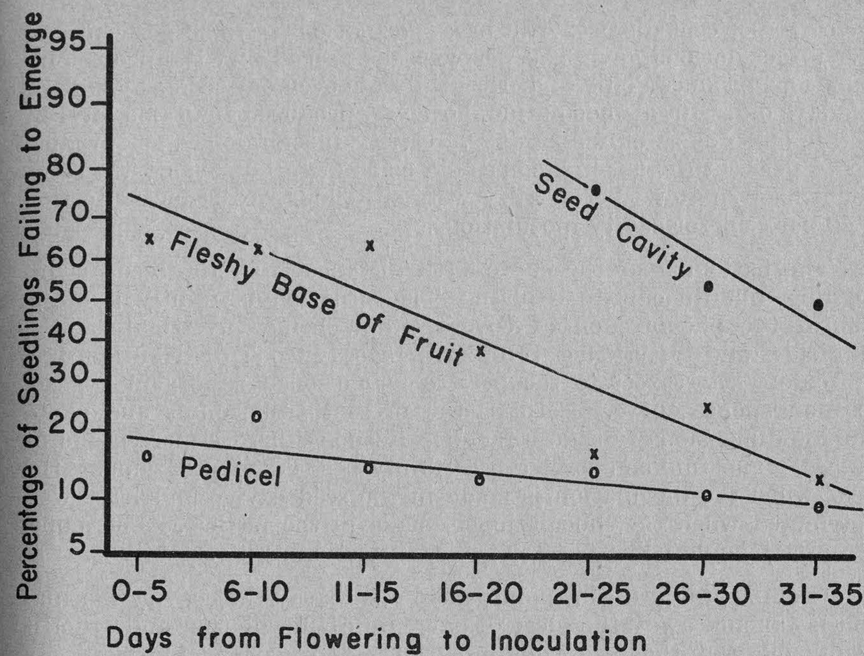
That error does not occur in the data on time, however. A graphic exploration of the data very soon reveals that the best straight line for the time response may be had with arithmetic probability paper using percentage of disease on the probability axis.

The available data, therefore, were plotted (Figure 3). Although variability about the line is understandably large, there seems to be no suggestion of other than linearity for any line except that for the data on emerged seedlings from fruit inoculated at the base.

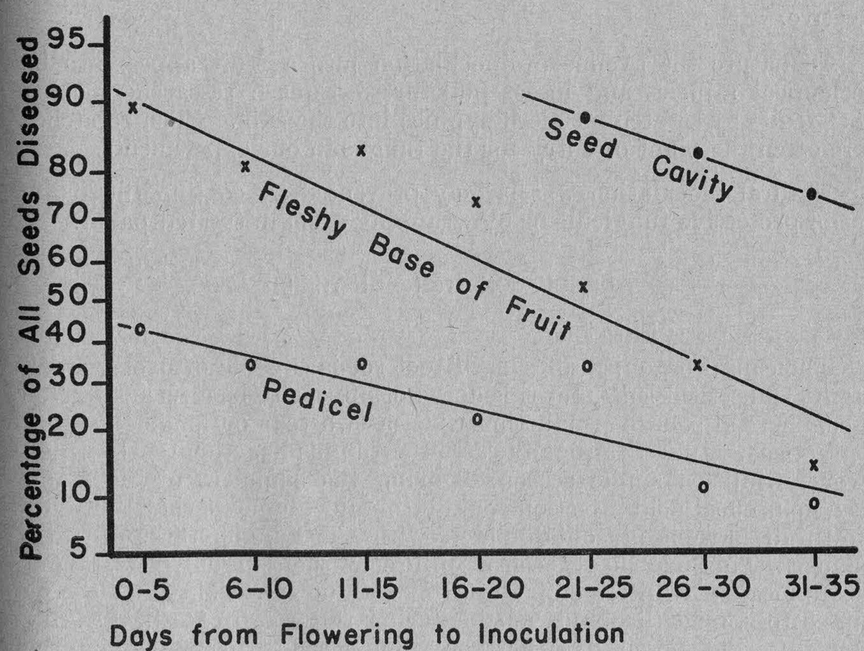
Two results are obvious: First, the curves are displaced progressively to the left and flattened as the distance from the seed cavity increases. The displacement may be viewed in two lights (1) that the percentage of contaminated seeds decreases with distance or (2) that a longer time is required as distance increases to give the same amount of disease. To take the case of total disease when inoculations were made 26 to 30 days after blooming, pedicel inoculations gave an aver-

TABLE 2. THE INFLUENCE OF THE AGE OF THE FRUIT AND THE PLACE OF INOCULATION WITH SPORES OF THE FOOT ROT FUNGUS ON THE VIABILITY AND DEGREE OF CONTAMINATION OF EARLY PROLIFIC SUMMER SQUASH SEEDS

Days from flowering to inoculation	Location of inoculation	Number fruits inoculated	Per cent fruits producing 95 per cent diseased seeds	Number normal seeds planted	Per cent seedlings failing to emerge	Per cent post-emergence disease	Per cent all seeds diseased
0 – 5	Pedicel	17	11.8	750	15.6	31.4	42.1
	Fleshy Base	13	84.6	200	65.5	68.1	89.0
	Seed Cavity	10	100.0	...	...	...	...
6 – 10	Pedicel	11	0.0	550	23.1	11.8	32.2
	Fleshy Base	11	63.6	200	61.5	46.8	79.5
	Seed Cavity	8	87.5	100	100.0	...	100.0
11 – 15	Pedicel	15	6.7	700	13.6	22.0	32.6
	Fleshy Base	15	73.3	200	64.0	51.4	82.5
	Seed Cavity	9	88.9	100	95.0	100.0	100.0
16 – 20	Pedicel	4	0.0	200	13.0	10.3	22.0
	Fleshy Base	4	50.0	200	37.0	56.3	72.5
	Seed Cavity	6	100.0	...	...	...	100.0
21 – 25	Pedicel	5	0.0	250	13.5	4.6	34.0
	Fleshy Base	6	0.0	300	16.0	17.2	53.7
	Seed Cavity	7	57.1	150	76.5	61.7	88.0
26 – 30	Pedicel	2	0.0	100	11.0	0.0	11.0
	Fleshy Base	5	0.0	250	23.6	12.6	33.2
	Seed Cavity	5	20.0	200	52.0	63.5	82.5
31 – 35	Pedicel	5	0.0	250	9.2	0.4	9.6
	Fleshy Base	6	0.0	300	12.3	1.1	13.3
	Seed Cavity	6	0.0	300	50.7	47.3	74.0



A. Based on percentage of seedlings failing to emerge.



B. Based on percentage of total disease.

Figure 3. Effect of age of fruit and location of inoculation on percentage of disease in seeds.

age of 11 per cent disease, fruit base inoculations gave 33 per cent and cavity inoculations gave 82.5 per cent disease. Likewise, pedicel inoculations produced only 42 per cent disease even on seeds as young as 2½ days old. Basal inoculation, however, produced the same level of disease on seeds as old as 25 days. Cavity inoculations were producing 74 per cent disease in seeds as old as 33 days. Probably the seeds would have matured before they were old enough to reduce infection to 42 per cent for cavity inoculations.

The flattening of the curve with distance from the seeds is intriguing, but difficult to explain. The situation is faintly reminiscent of the phenomenon of coverage now being investigated with fungicides and insecticides (Horsfall, 1945). Good distribution of a pesticide with respect to the pest to be poisoned results in a steep dosage-response curve. Perhaps the present situation is analogous. Time is dimensionally a dose factor. Response here is percentage of disease. The fungus spores are certainly best distributed among the seeds when the inoculation is made in the seed cavity and least well distributed when the inoculation is made in the pedicel. The slope, therefore, should be flattest for pedicel infection as it certainly is.

From a practical viewpoint, these results say that cavity inoculation is far and away the most drastic site of inoculation and from it results most of the seed contamination. Inoculations in the fleshy base were much less effective and inoculations in the pedicel were least effective.

In nature the avenue of inoculation into a fruit appears to be mechanical injuries and insect punctures. Squash researchers often label fruits by scratching hieroglyphics into the skin. Such scratches were often the point of entry for the fungus in our experiments.

Natural inoculation was largely prevented by coating the fruits with a protective fungicide or by wrapping them in treated paper.

EFFECT OF SOIL CONDITIONS ON THE DISEASE

Longevity of the Fungus in the Soil

The causal organism of squash foot rot is capable of over-wintering in Connecticut soils, but this does not appear to be a serious factor in commercial squash production when a two-year or longer rotation is practiced. Indeed, in many cases the fungus has apparently failed to over-winter a single season. During the summers of 1943 and 1944, no natural field infection could be obtained on experimental plots known to have been contaminated with the fungus the preceding summer. This may have been a failure of the fungus to withstand the Connecticut winters or may have been due to the inability of the fungus to spread through the soil during those two exceedingly dry summers. The possibility that the fungus could not withstand the association effects of other soil organisms is tendered considerable credence by an experiment conducted simultaneously.

Effect of Organic Matter

In the spring of 1943 naturally contaminated fine sandy loam, low in organic matter, was collected and divided into three portions. One portion was mixed with an equal volume of sand, one with an equal amount of well-composted squash vines, and one received no amendment. These three soil types were placed in screen-bottomed boxes 10″ x 3″ x 8″ and buried to the surface level of the soil. Each box was given a "booster" inoculation of Fusarium spores. At intervals during the next two years, representative boxes were removed and taken to the greenhouse. There the soil was potted and planted with uncontaminated squash seed. Disease readings on the plants grown in these soils were indicative of the longevity of the fungus in the three soil mixtures. In Table 3 is shown the presence of *Fusarium solani* f. *cucurbitae* in the field soil, humus-amended soil and sand-amended soil as determined by the incidence of foot rot over a period of two years following preparation of the soil types.

TABLE 3. LONGEVITY OF *F. solani* f. *cucurbitae* IN THREE SOIL TYPES AS INDICATED BY THE ABILITY OF THE SOIL TO PRODUCE DISEASE ON HEALTHY SEEDLINGS
Two samples were used for each test

Date of test	Months from test initiation	Field soil	Sand-amended soil	Humus-amended soil
November, 1943	6	++	++	++
March, 1944	10	++	++	++
October, 1944	17	++	Not tested	00
April, 1945	23	++	++	00
August, 1945	27	0+	++	00

It is especially interesting to note that the fungus did not persist as long in the humus-amended soil as it did in either of the other two soil types. Either of two theories might explain this behavior. First, the increased microbiological activity of saprophytic organisms might usurp the nitrogen supply and effectively starve the pathogene for this essential element. This is known to occur in the case of certain other soil-borne parasites. Soil analyses run on the various samples, however, refute this theory since they showed a higher available nitrogen content in the humus-amended soil than in either of the other two.

The remaining theory advanced here to explain the relatively short existence of the foot rot Fusarium in the soil with a high organic matter content is that of antibiosis. Waksman and Horning (1943) and other authors have pointed out the omnipresence of soil organisms which produce antibiotic substances. It is quite probable that in the organic-amended soils, such organisms thrived and produced substances toxic to *F. solani* f. *cucurbitae*. In the field soil and sand-amended soil, the biological activity of such organisms must necessarily have been lower because of the limited nutritive conditions prevailing there.

The results of this experiment coincide with several observations made on the survival of the foot rot fungus in soil and in organic compost. In one case, year-old compost originally containing diseased squash fruit and vines failed to serve as inoculum when transferred to the greenhouse for experimental purposes. This observation lends support to the antibiosis theory since this compost had been prepared after established commercial procedures and thus always should have contained a sufficient supply of available nitrogen.

In both of the cases mentioned above, when no natural infection occurred the next season after a heavy infestation of foot rot the preceding year, a heavy crop of rye had been turned under in the spring. This additional organic matter may have been responsible for the failure of the disease to develop.

Effect of Other Microorganisms

In all cases of squash foot rot found at our Mount Carmel experimental farm during the summers of 1942 and 1943, an unidentified species of bacterium seemed invariably to be associated with the Fusarium in the rotting portions of the stem. It was thought advisable to test the pathogenicity of this organism to squash, both alone and in combination with the fungus. To attain this end, four groups of 10 mature plants each were inoculated on June 22, 1943, by means of injection with a two-cubic centimeter laboratory syringe into the stem base with the following inocula.

Each plant from one group of ten was inoculated with two cc. of a suspension of *Fusarium solani* f. *cucurbitae* spores at the rate of 1,000 spores per cc. The plants in the second group each received two cc. of a suspension of cells of *Bacterium* sp. at approximately 5,000 cells per cc. A third group of plants were inoculated with one cc. of a Fusarium spore suspension containing 2,000 spores, and with one cc. of a suspension of bacterial cells containing 10,000 cells. The plants in the fourth series were injected with two cc. of sterile distilled water.

Disease readings were made on these plants at intervals for five weeks, and the severity of the disease scored into four groups: (S) plants showing a softening around the point of inoculation; (R) plants showing a visible rotting of the basal portions of the stem; (W) those definitely wilting in addition to rotting; and (D) those plants which had collapsed and could be considered dead. These groups are artificial to be sure and do not represent equal time increments in the development of the disease after inoculation. The wilting stage especially is misleading since this symptom is associated so closely with climatic and edaphic factors. The progress of disease in the different groups of plants is shown in Table 5.

From the presence of *Fusarium solani* f. *cucurbitae* in such a high percentage of the plants dead in the bacterial-inoculated and

TABLE 5. INFLUENCE OF A SPECIES OF BACTERIUM UPON THE PROGRESS OF THE FOOT ROT DISEASE AFTER INOCULATION OF MATURE HEALTHY PLANTS
No. of plants affected[1]

Inoculum	Stage	Days after inoculation							Recovery of Fusarium
		8	14	16	21	26	30	35	
Fusarium	S	3	4	2	..	..	..	..	
	R	1	2	3	1	..	..	..	
	W	1	..	2	3	..	..	..	
	D	..	3	3	6	10	10	10	10
Bacterium	S	..	..	..	6	3	..	..	
sp.	R	..	..	..	4	3	5	..	
	W	..	..	..	..	..	1	..	
	D	..	..	..	..	4	4	10	8
Fusarium	S	..	2	5	..	..	..	..	
and	R	1	..	3	6	3	2	2	2
Bacterium	W	..	1	..	..	..	1	..	
	D	..	..	1	4	7	7	8	8
Sterile	S	..	..	..	9	9	7	5	2
water	R	..	..	..	1	1	2	..	
check	W	..	..	..	..	..	1	..	
	D	..	..	..	..	..	..	5	5

[1] 10 plants inoculated.

check series at the end of five weeks, it appears that the experiment was considerably confounded by the secondary spread of the fungus either by insects, wind or some other agent.

The most significant conclusion to be drawn from the table is that the presence of the bacterium does not synergize the development of disease, but actually seems to decrease the virulence of the fungus pathogene. The mode of this action is not clear, but may easily be a case of mild antibiosis.

The presence of Fusarium in all five of the check plants which died and in eight out of 10 of the bacterium-inoculated plants indicates that the bacterium is probably purely saprophytic. The failure to find the fungus in two cases out of 10 when the plants had been inoculated with the bacterium alone may have been due to technique or may indicate that this normally saprophytic bacterium can under certain conditions kill the living tissue by extracellular enzymatic action and can actually cause a diseased condition of the plant. That this bacterium is parasitic is extremely doubtful since no cases have been found in Connecticut of a diseased squash containing this organism alone, although it or a similar species is ubiquitous on wounded squash tissue and attacks such tissue with equal facility whether it be stem, root or leaf. Experiments were run in the greenhouse during the winter of 1943 in which the bacterium was surface-inoculated on plants. It was conclusively shown that the bacterium lacked any ability to penetrate uninjured stem tissue.

During the summer of 1943, two Fusaria not identical with our strain of *Fusarium solani* f. *cucurbitae* were isolated from diseased

plants along with the known pathogene. These were included along with the known pathogene in pathogenicity trials the following summer and both proved to be purely saprophytic in nature.

EFFECT OF CALCIUM-POTASSIUM BALANCE

It seemed worthwhile to investigate the effect of calcium and potassium on the development of the disease. A companion study on potato scab was already underway. A simple test was made the first year (1942). Calcium hydroxide and sulfur were added to infested soil and plants were grown. Although all treated plants finally succumbed to the disease despite treatment, it seemed significant that treatment did affect the time for appearance of symptoms. The period between planting the healthy seeds in the infested soil and the development of symptoms was shortened considerably for the lime plots as compared with the check plots. The lime seemed to have encouraged the disease. These data are in keeping with the known preference of the parasitic Fusaria for alkaline conditions.

This initial result did not distinguish the effect of the Ca– from the –OH in the $Ca(OH)_2$ molecule. Indirectly, the –OH was suggested as the cause by the fact that the addition of sulfur in the same experiment delayed the development of symptoms on healthy seedlings.

The experiments were extended during the next two summers. In 1943, another variable was introduced. If the calcium ion, perchance, and not the –OH ion, had been responsible, then potassium should antidote the effect of soil calcium and reduce the disease. Therefore, calcium hydroxide and sulfur as before, were compared with potassium chloride at three doses each (Table 4).

Despite some heterogeneity in the results, it is clear that the calcium hydroxide again increased the disease. As before, it accelerated the rate of involvement of the plants as well. Although sulfur reduced the –OH ion in the soil, it did not seriously affect the percentage of disease until the pH became very low. Potassium reduced the total disease and the rate of involvement without reducing the pH greatly.

TABLE 4. INCIDENCE OF SQUASH FOOT ROT IN INORGANIC AMENDMENT PLOTS IN 1943

Amendment	Rate per acre in pounds	Soil reaction	Number of plants	Per cent diseased
Calcium hydroxide	250	pH 5.7	74	28.4
	500	6.4	72	43.2
	1,000	6.8	74	39.2
Potassium chloride	250	5.4	76	19.8
	500	5.7	78	25.7
	1,000	5.5	68	19.2
Sulfur	250	5.4	74	27.0
	500	5.0	63	25.4
	1,000	4.2	71	21.1
Check	...	5.7	74	25.7

A series of laboratory studies were made on the effect of the ratio between calcium and potassium on the fungus and on the reaction of squash plants to the disease. In nutritional studies with the fungus, no effect of calcium, or of calcium-potassium ratios could be found until the absolute amount of potassium present in the medium was reduced so as to be actually limiting. High Ca/K nutrient solutions did not appreciably affect fungus growth so long as there was enough total potassium for the nutrition of the fungus.

To test the effect of the calcium and potassium nutrition of summer squash on its reaction to the disease, healthy plants were started and grown in sterile sand cultures supplied with three different nutrient solutions, varying only in the ratios of calcium and potassium which they contained. After two weeks, no difference could be noted in the growth characteristics of the plants grown in the various calcium-potassium ratios. At this time all plant cultures were inoculated with the foot rot organism. The progress of the disease as it occurred under these three different calcium-potassium ratios is charted in Figure 4.

It may be seen that, here again, when the total amount of disease at the end of the growing season is considered, there is no difference between the results obtained between plants growing under the different nutritional conditions. All plants eventually became infected and died in every case. Only when the progress of the disease among the entire population is observed are the differences in disease reaction noticeable.

In keeping with the earlier appearance and higher incidence of the disease on the calcium plots in the field, the amount of disease at any given time in the sand cultures was higher when the Ca/K has a high than when it has a low value. The progress of the disease on the medium and low Ca/K ratios constantly lagged behind the disease development on the plants grown with the very high Ca/K ratio.

As a result of these experiments, it seems safe to say that the development of squash foot rot is affected by the calcium and/or potassium nutrition of the host plant. Apparently, high calcium and low potassium encourages the disease and high potassium and low calcium discourages it. The mechanism of this action is obscure. One is inclined to say that potassium lends resistance to this Fusarium disease as it does to the Fusarium wilt of cotton. On the basis of the data one could say also that it reduces the effect of calcium in encouraging the disease.

In the case of potato scab which has been studied much more extensively, the effect of Ca/K is multimodal (Gries, Horsfall and Jacobson, 1944). The high point in the middle dosage range for calcium and potassium in Table 4, suggests that a similar relation may hold here also.

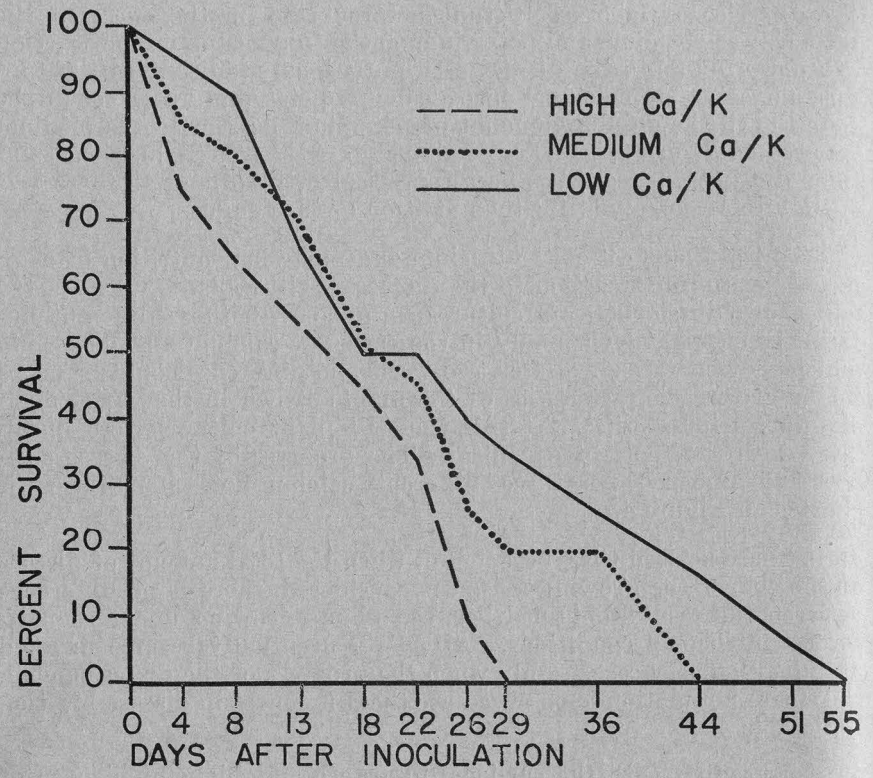


Figure 4. Survival of Early Prolific squash plants grown in sand culture in three nutrient solutions varying only with the ratio of calcium to potassium.

The experiments discussed above are disappointing, perhaps, to the practical man because no ratio of calcium and potassium were discovered which would even approach commercial control under conditions of severe disease. They do suggest, however, that the use of potassium and the avoidance of lime might be good practice.

SUMMARY

1. Foot rot is a disease of squash caused by the fungus *Fusarium solani* f. *cucurbitae* (*F. javanicum* v. *theobromae*). The most noticeable symptoms of the disease are the wilting and dying of the host plant following the rotting of the stem tissue near the soil level. The fungus also causes a fruit rot, although the importance of this stage is largely of concern to the seed producer. This species of *Fusarium* is capable of causing the disease of *Cucurbita pepo*, *C. moschata* and *C. maxima*. In Connecticut it has been most destructive to *C. pepo* and to the progeny of crosses involving this species as one of the parents.

2. Foot rot is a seed-borne disease. The fungus is carried as spores on the surface of the seed or as mycelium in the seed coat. Occasionally, it is found as sporulating mycelium in the embryo of the seed. True seed infection occurs only in fruits affected with the fruit-rotting stage of the disease, although surface-borne contamination is often effected through the fermentation process in the recovery of the seeds. The fungus seems to die out of the seed after two years of storage.

3. Hot water therapy has been successful in sterilizing seeds infected with the mycelium in the seed coat. This procedure is attended by an appreciable reduction in germination, however. Surface contamination can be controlled by a 15-minute immersion of the seeds in a 1:1000 corrosive sublimate solution. No success has been had in limited attempts to protect healthy seedlings in infested soils with chemical seed treatments.

4. The fungus causing foot rot may overwinter in the soil although, under Connecticut conditions, this is not a serious factor in the production of squash. The fungus is relatively short-lived in soils amended with organic matter. This is believed to be the result of the antibiotic effects of other microorganisms, rather than being a matter of competition for nutrients. In no case has the fungus been known to remain active in commercial fields for more than two winters.

5. Soil amendments of sulfur and potassium chloride delay the development of disease symptoms in the field by periods up to two weeks, while hydrated lime hastens the development of the disease. It is suggested that this may be a function of the calcium and/or potassium nutrition of the host plant, although it may be effectively duplicated by changing the soil reaction. Thus, the disease develops more rapidly in alkaline than acidic soils. It is suggested that lime be used sparingly where the fungus causing this disease is suspected of being present in the soil.

6. While no insects have been proved to be vectors of the disease, a thorough program of insect control should be practiced wherever this disease is known to be prevalent.

7. A species of bacterium commonly associated with the disease in Connecticut has been shown to have no role in its etiology. In inoculation studies this bacterium has actually been shown to slow down the development of disease symptoms rather than to synergize their appearance.

LITERATURE CITED

BEARD, R. L. Unpublished data, 1942.

CHUPP, C. Vegetable disease notes in New York. Plant Dis. Rptr. 23:218-219. 1939.

DOIDGE, E. M. AND L. J. KRESFELDER. A wilt disease of Cucurbits. Farming in South Africa 7:299-300. 1932.

GRIES, G. A. The effect of plant decomposition products on root diseases. Phytopath. 33:1111. 1943.

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

HORSFALL, J. G. Fungicides and their action. Chronica Botanica, Boston. 1945.

SCHROEDER, R. A. AND W. A. ALBRECHT. Plant nutrition and the hydrogen ion: II. Potato scab. Soil Sci. 53:481-488. 1942.

SNYDER, W. C. A Fusarium foot rot of Cucurbita. Phytopath. 28:19. 1938.

———— AND H. N. HANSEN. The species concept in Fusarium with reference to section Martiella. Amer. Jour. Bot. 28:738-742. 1941.

WAKSMAN, S. A. AND E. S. HORNING. Distribution of antagonistic fungi in nature and their antibiotic action. Mycologia 35:47-65. 1943.

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CONNECTICUT AGRICULTURAL EXPERIMENT STATION, NEW HAVEN, CONNECTICUT

45th Report, 1945

CONNECTICUT STATE ENTOMOLOGIST

Bulletin 501 August, 1946

R. B. FRIEND, Ph.D.
State Entomologist

CONNECTICUT AGRICULTURAL EXPERIMENT STATION, NEW HAVEN, CONNECTICUT

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

I have the honor to transmit, herewith, the forty-fifth report of the State Entomologist for the year ending October 31, 1945.

Respectfully submitted,

ROGER B. FRIEND,
State and Station Entomologist

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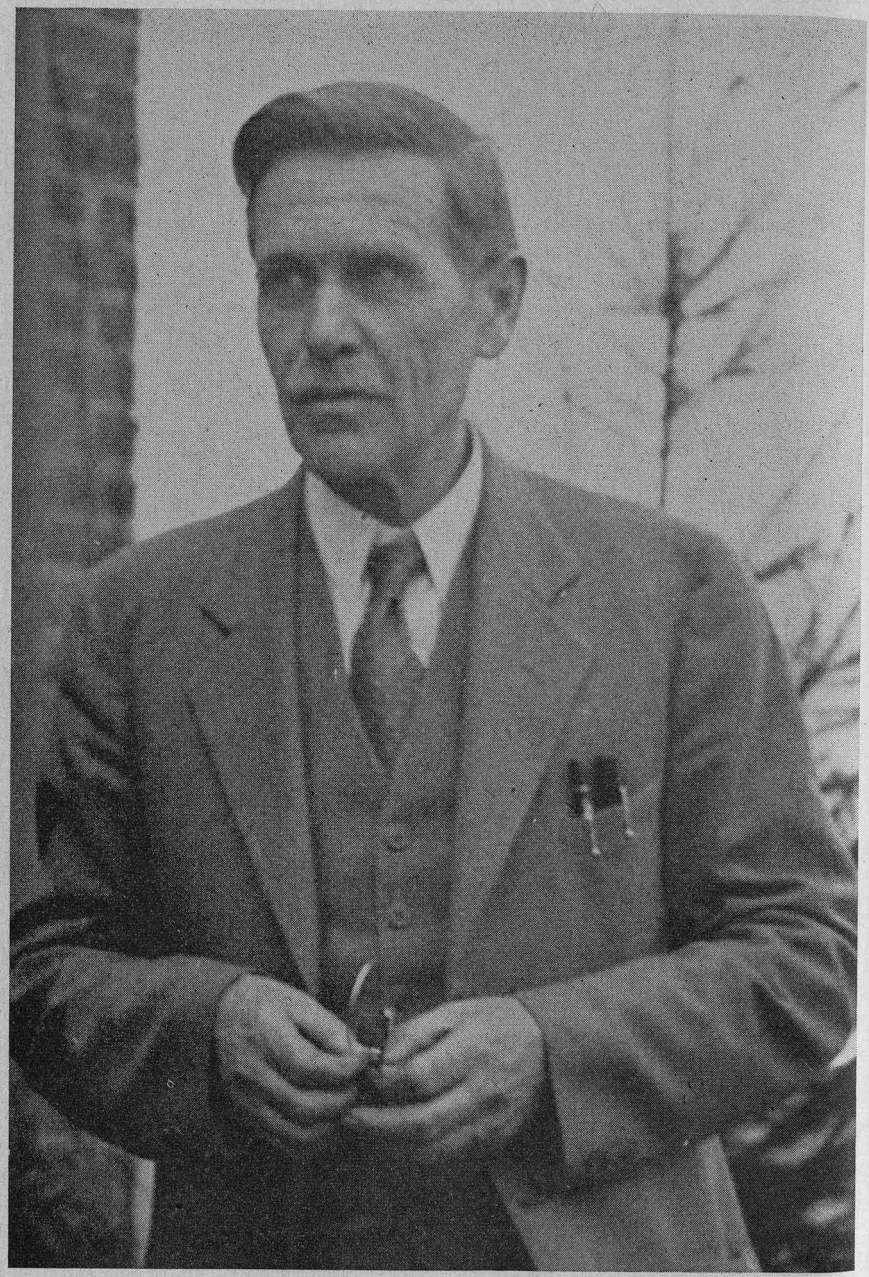


Benjamin Hovey Walden

BENJAMIN H. WALDEN

June 3, 1879 — January 6, 1946

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

Mr. Walden's duties were many and varied, for at the time of his appointment he was the only assistant to the entomologist and for a number of years the staff was small. For a long period of time he did all the photographic work, and the excellence of the illustrations in the department's publications attest his skill. Doctor Britton, the entomologist, was much interested in the control of the San José scale up to about 1911, and Mr. Walden assisted him in the field experiments being carried out. Later they carried out a series of experiments in the control of the white pine weevil and certain other pests. Mr. Walden also studied the biology and control of a number of agricultural and household pests and carried out a series of fumigation experiments. In the regulatory and field control work of the department, he assisted in nursery inspection and gypsy moth control and for a few years was in charge of mosquito control.

In the field of taxonomy and identification, Mr. Walden showed considerable ability, and the insect collection at the Experiment Station was under his care. He was an authority on Orthoptera and Hemiptera, and in 1911 published "The Euplexoptera and Orthoptera of Connecticut", a bulletin of the Connecticut Geological and Natural History Survey. His remarkably retentive memory and extensive knowledge of Connecticut insects enabled him to handle the general correspondence regarding insect pests expeditiously.

During his long and useful career Mr. Walden exemplified those personal qualities which endeared him to his colleagues and friends. He was modest and unassuming, yet helpful, particularly so to younger members of the staff. Endowed with uncompromising integrity and loyalty, he displayed an admirable forthrightness at all times. He was, in thought and deed, beyond reproach.

Mr. Walden is survived by his wife, Anna Conger Walden; one son, David C. Walden,[1] a chemist at this Experiment Station; three daughters, Elizabeth Walden of New Britain, Conn., Mrs. Earle Humiston of Devon, Conn., and Laura Walden of Hamden, Conn.; one brother, Louis H. Walden of Norwichtown, Conn.; and five grandchildren. He lived in Hamden.

R. B. FRIEND

[1] David C. Walden died on September 13, 1946.

CONNECTICUT STATE ENTOMOLOGIST

FORTY-FIFTH REPORT

1945

R. B. Friend

WORK OF THE DEPARTMENT

The most conspicuous trend in economic entomology in this country during the past few years has been the intense interest in insecticides. This was stimulated by the necessity for the better protection of military personnel from pests which transmit disease to man, and for the better control of insects which attack agricultural crops, livestock, forests and manufactured products. The insecticidal properties of a number of chemical compounds have been determined and better methods of applying them have been developed. The work of the Department, as far as the research phases are concerned, has followed this trend to a certain extent and our insecticidal research has received more emphasis than in previous years. Particular attention has been devoted to studies of adhesives for spray mixtures used in the orchard, the efficiency of insecticidal dusts used for the protection of field and truck crops, the relation of chemical composition to toxicity, the durability of DDT residues, and the development of apparatus for distributing concentrated sprays.

In addition to this increase in insecticidal research mentioned above, we have continued to study several entomological problems of importance to Connecticut agriculture and forestry. Among orchard pests, the Oriental fruit moth, the apple maggot, the Japanese beetle, Comstock's mealybug and the codling moth have received particular attention. As regards the pests of field crops, certain studies of the control of the European corn borer, potato pests, and wireworms have been carried out. The eastern field wireworm is the worst insect pest of potatoes in this State and often severely injures young tobacco plants.

Scarabaeid beetle larvae are particularly injurious to plants by virtue of their destruction of the root system. The Japanese beetle is the most notorious member of this family. Larvae of this insect react quite definitely to temperature gradients, and the effect of temperature on the toxicity of lead arsenate applied in the soil to Japanese beetle grubs has been investigated. One of the most significant developments in biological control in recent years has been the utilization of bacteria to suppress populations of Japanese beetle grubs. The biological aspects of the relation of these bacteria to the grubs have been studied in detail.

Some attention has been devoted to a study of pests of forest and ornamental trees. One of the most interesting problems involved is the nature of injury caused by insects. In this field a rather detailed study of the spruce gall aphid on Norway spruce is being carried out.

Boring insects are sometimes very injurious to ornamental trees, both in the nursery and after setting out, and an attempt has been made to develop control measures for certain of these pests. Another pest of ornamentals, Comstock's mealybug, is quite injurious to yew (Taxus), and the control of this insect has been worked out.

The honeybee is a useful insect whose value far exceeds the returns gained by selling two of its products—honey and beeswax. As a pollinator of agricultural plants, it is indispensable. One of the greatest hazards of beekeeping is the disease called American foul brood. The control of this by sulfathiazole was first reported by Haseman of the Missouri Agricultural Experiment Station and was tried here last year with considerable success. If further investigations support the results attained to date, we should have at hand a means of controlling this disease without completely destroying the diseased colony as is done at the present time. Another hazard in apiculture is the poisoning of bees by insecticides used to control pests. This problem, which under certain conditions may be very serious, is being investigated.

For some years the Department has been responsible for a series of bulletins published by the Connecticut Geological and Natural History Survey under the general title "Guide to the Insects of Connecticut". Bulletin No. 68, dealing with the mosquitoes of Connecticut, and written by Professor Robert Matheson of Cornell University, was published this year. Other manuscripts dealing with the Diptera are at hand and will be published as soon as possible.

The Department handles a great deal of correspondence regarding insect pests and other small injurious animals. During the year 394 specimens received by mail were identified and the correspondents informed of their injuriousness and methods by which they may be controlled. Tables 1 and 2 give a general summary of this work. It should be noted that the predominance of certain species received at this office does not reflect by any means their importance to the welfare of the State.

TABLE 1. SUMMARY OF SPECIMENS RECEIVED, 1945

	Number of samples received
Pests of the household and stored grain	200
Forest and shade tree pests	63
Flower garden and greenhouse pests	20
Pests of shrubs and vines	18
Field and vegetable crop pests	16
Fruit pests	12
Soil and grassland inhabiting pests	12
Timber and wood products pests	12
Insects annoying to man and domestic animals	6
Parasitic and predaceous insects	3
Miscellaneous	32
	394

TABLE 2. INSECTS RECEIVED FIVE OR MORE TIMES, 1945

	Times received
Elm leaf beetle, *Galerucella luteola* Mull.	55
Black carpet beetle, *Attagenus piceus* Oliv.	12
Termite, *Reticulitermes flavipes* Koll.	12
Pavement ant, *Tetramorium caespitum* Linn.	12
Carpenter ant, *Camponotus herculeanus pennsylvanicus* DeG.	10
Euonymus scale, *Chionaspis euonymi* Comst.	9
Ants (miscellaneous)	8
Indian meal moth, *Plodia interpunctella* Hubn.	8
Orange-striped oak worm, *Anisota senatoria* S. & A.	5
Privet thrips, *Dendrothrips ornatus* Jab.	5

The members of the Department have published several papers during the year on various aspects of their work. A list of these are printed on pages 115 and 116. Inasmuch as the author's name appears on each contribution to this Report, the articles published here are not included in the list.

In addition to this general research program, certain inspection and control operations are carried out under the direction of this office. The inspection of nurseries and apiaries, and such inspection work as is necessary to the enforcement of Japanese beetle and European corn borer quarantines were carried out as usual. The three control operations that concern gypsy moth, Dutch elm disease and the Oriental fruit moth were also carried out in the usual manner.

Mr. Philip P. Wallace, a member of the Experiment Station staff since 1934, resigned July 31, 1945, to take a position with the Ensign Bickford Company of Simsbury, Connecticut. While employed at this Station, Mr. Wallace was engaged in Dutch elm disease control work, research on bark beetles, borers, and other pests of ornamental trees and shrubs, and a study of certain methods of applying DDT. He made many valued contributions to our knowledge of the biology and control of injurious insects.

Mr. W. H. Kelsey, employed as an apiary inspector since 1935, resigned effective January 1, 1946. Mr. Kelsey discharged his duties faithfully and efficiently at all times, a staff member whose loyalty never wavered and whose integrity was never questioned. We wish him well.

PREVALENCE OF INSECT PESTS

The most interesting insect of the year, from the entomological viewpoint, was the periodical cicada (*Magicada septendecim* L.) Brood II of this insect appeared on schedule 17 years after its last appearance in the State and in about the same places, that is, a group of towns extending from East Haven, Branford and Guilford on the Sound north to Farmington, West Hartford and Avon (Figure 1). The adults (Figure 2) were first noticed near New Haven on May 22 and continued to be present about six weeks. They declined in numbers rapidly after July 1, and the last one observed was seen July 9. Egg deposition became general in North Branford on June 18; and severe injury to apple, peach, elm, oak, maple, birch, sassafras, spicebush, and other trees and shrubs became quite prevalent (Figure 3), particularly in the region from North Branford to Middletown. The injury to the trees, at least as far as the parts above ground are concerned, is due to the egg-laying habits of the females which slit the twigs with the ovipositor in order to deposit eggs therein. This weakens the twigs and they are easily broken (Figure 4), those as large as one-half inch in diameter being affected. Injury to young fruit trees is particularly serious. Most of the information on the 1945 prevalence of cicada was obtained by Mr. B. W. McFarland of this office.

Many other insects which have been injurious to orchards in times past were more or less prevalent during the year. The Japanese beetle (*Popillia japonica* Newm.) increased in abundance in some parts of the State. The Oriental fruit moth (*Grapholitha molesta* Busck) was more numerous than in 1944, and much injury to fruit occurred in some orchards. The European apple sawfly (*Hoplocampa testudinea* Klug) was not as abundant as in 1944 and no great amount of damage occurred. Comstock's mealybug (*Pseudococcus comstocki* Kuw.), which has been at times a pest of apples and pears, was also less injurious than last year. The codling moth (*Carpocapsa pomonella* L.) caused somewhat more damage than in previous years, the population building up after July 1. We have by no means the intensity of infestation of this pest that occurs in apple orchards in other parts of the country. The apple maggot (*Rhagoletis pomonella* Walsh), which appears to be always with us, was quite injurious, and the flies occurred in the orchards until harvest in some cases. This delayed flight of adults made control operations somewhat complicated. The plum curculio (*Conotrachelus nenuphar* Herbst) and plant bugs (*Lygus* spp.) were severely injurious to peaches in several orchards. Many unsprayed apple orchards in New Haven and Middlesex counties were stripped of foliage in June by the fall canker-worms (*Alsophila pometaria* Harr.)

One of our most serious pests of field and truck crops continues to be the European corn borer. Most of its injuriousness is confined to corn. Dr. Vance of the Federal Bureau of Entomology and Plant

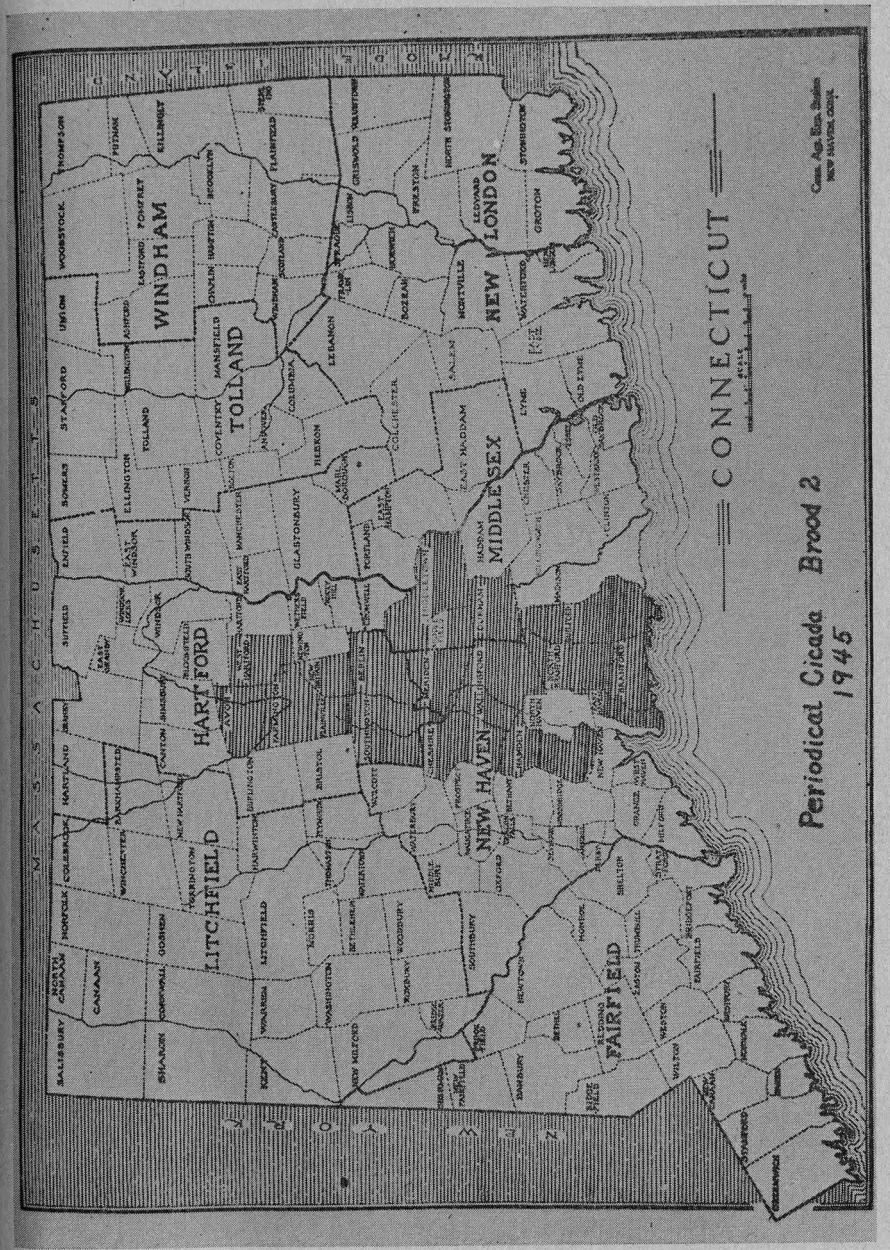


Figure 1. Distribution of the periodical cicada in 1945.

Figure 2. Adults of the periodical cicada on dogwood.

Figure 3. Left: oviposition scars of the periodical cicada on elm.
Right: eggs of periodical cicada in apple twig. (X 3).

Figure 4. Left: cicada injury to small apple tree.
Right: cicada injury to small elm tree.

Quarantine makes an annual survey of corn borer damage throughout the infested area in the United States. The degree of damage is estimated on the basis of the number of borers found per plant. According to Vance, the fall infestation in 1945 was fairly heavy in places, New Haven County having one of the highest populations in the East, 389 borers per 100 plants. Early sweet corn was much less injured than in 1944, the average infestation being two borers per plant. In all eight Connecticut counties the fall infestation averaged 145 borers per 100 plants, which is not considered heavy. In five counties for which comparable data for previous years are available, the fall infestation was 162.6 borers per 100 plants in 1944 and 179.2 in 1945, not significantly different. Vance's data are summarized in Tables 3 and 4 below:

TABLE 3. CORN BORER DAMAGE, 1945

	Entire infested area in U. S.			Connecticut	
	Acres	Crop value	Crop loss	Crop value	Crop loss
Grain corn	15,968,983	$1,141,649,989	$32,846,459 (89.3%)	$541,334	$27,924 (11.8%)
Sweet corn	306,702	32,498,410	3,918,106 (10.7%)	1,100,400	208,722 (88.2%)
	16,275,685	$1,174,148,399	$36,764,565	$1,641,734	$236,646

TABLE 4. CORN BORER INFESTATION IN FALL

County	Borers per 100 plants	
	1944	1945
Fairfield	177.4	108.4
Hartford	357.8	200.0
Litchfield	99.8	53.6
Middlesex	110.2	145.0
New Haven	68.0	389.0
New London		131.4
Tolland		63.2
Windham		69.4

Some pests of field and truck crops were quite prevalent. Flea beetles (*Epitrix cucumeris* Harr.) were injurious to potatoes and tomatoes in June, and the usual amount of wireworm injury to potatoes occurred. Another pest of truck crops, the cabbage maggot (*Hylemyia brassicae* Bouché) was moderately to severely abundant in southwestern Connecticut in May.

Our worst pest of forest and shade trees, the gypsy moth (*Porthetria dispar* Linn.) was not excessively abundant in Connecticut in 1945, and no extensive defoliation occurred. On the contrary, canker-worms (*Alsophila vernata* Peck) were quite abundant on shade and forest trees in May and June. The orange-striped oak worm (*Anisota senatoria* A. and S.) is quite frequently injurious in eastern Connecticut, and a rather heavy outbreak occurred in that part of the State in September. The eastern tent caterpillar (*Malacosoma americana* Fabr.), which is sporadically abundant in various parts of the State, was quite conspicuous in southern Connecticut. The elm leaf beetle (*Galerucella luteola* Mull.) infestation was heavy in Stamford and the region surrounding that town and many trees were stripped of foliage. The fall webworm (*Hyphantria cunea* Dr.) was very abundant in eastern Connecticut during the last part of the summer. One of the most conspicuous enemies of the black locust is the locust leaf miner (*Chalepus dorsalis* Thunb.) This insect was quite abundant in certain parts of the State in July.

INSPECTION OF NURSERIES, 1945

M. P. ZAPPE AND L. A. DEVAUX

The annual inspection of nurseries as required by Section 2136 of the General Statutes began on July 2, 1945. Two temporary inspectors, F. A. Luddington and F. M. Richards, were employed during July and August. Both of them had had previous experience, as they were employed in 1944. Mr. DeVaux worked with them during July and August and Mr. Zappe was with them part of the time when other duties permitted. On September 27 all regular inspections were finished, although occasional inspections were made after this date to see that nurserymen had made a proper clean-up of their nursery pests. The strawberry plant growers had their fields inspected during the latter part of June. Most of these are located in New London County.

The nurserymen had a very busy season in 1945. Help was scarce and many orders could not be filled. Most of the larger nurseries were well cultivated and in good condition but some of the smaller ones were rather weedy and in some cases cultivation was omitted entirely. Owners of some of the small nurseries were employed in essential war industries and their nurseries were neglected. Some were not even registered nor inspected, and are therefore out of business, at least temporarily.

The usual numbers of nursery pests were found, but no serious outbreak of any particular pest was noted. Only 12 nurseries had infestations of pine leaf scale compared to 53 in 1944. This may be partly due to the fact that some of the nurseries have fewer mugho pines than formerly. They are not particularly desirable plants and are subject to a number of pests. Out of a total of 302 nurseries inspected, 135 were free from pests. Seven plant diseases were found and reported during the inspection period, but most of these were of a minor nature and were not considered serious.

Wood borers are probably the most serious insect pests of Connecticut nurseries. Those in linden and mountain ash appear to be most abundant and difficult to control. This is particularly true of trees grown in grass and weeds. Where clean cultivation is practised, there are fewer infested trees.

Of the scale insects, oystershell scale was the most abundant and was found in 66 nurseries. This scale is particularly abundant on willows, poplars, ash, lilac and older fruit stock. It rarely occurs on fruit stock less than three years old. No peach "X" disease was found in any Connecticut nursery in 1945. Peach trees in Connecticut are grown under special conditions so that they will be free from this disease. The regulations require that all chokecherries be removed within a 500-foot zone around the peach blocks. This must be done before the peach seedlings are above ground and they must be kept out of this area until the trees are finally harvested.

Dutch elm disease was found in or near seven nurseries. The diseased trees were immediately removed by the owners. Nectria canker on maples was present in 23 nurseries in 1944, but new cankers were found in only five nurseries in 1945.

TABLE 5. TEN-YEAR RECORD OF CERTAIN NURSERY PESTS

Pest	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945
European pine shoot moth	108	128	130	110	108	106	54	6	39	46
Oystershell scale	87	84	53	49	57	77	68	78	65	66
Pine blister rust	0	4	5	3	3	4	0	2	1	0
Pine leaf scale	72	60	25	50	48	46	23	10	53	12
Poplar canker	28	26	20	14	15	15	11	28	12	11
San José scale	11	8	2	1	2	7	4	10	15	15
Spruce gall aphids[1]	337	306	312	216	231	227	210	140	83	110
White pine weevil	82	101	97	93	70	61	27	28	31	37
Nurseries uninfested	26	25	32	19	33	32	126	148	123	135
Number of nurseries registered	380	377	402	399	376	356	331	318	297	302

[1] Includes both *Adelges abietis* and *A. cooleyi.*

One nurseryman received the special raspberry inspection and was granted a certificate, as no raspberry mosaic was found on any of his plants.

A total of 302 nurseries, five more than in 1944, were registered and inspected, but all have not been granted certificates as they have not completed the required clean-up of their pests. These nurseries have a total of 4,258 acres devoted to the growing of stock, approximately the same as in 1944. A classification of nurseries by size is given in Table 6.

TABLE 6. CLASSIFICATION OF NURSERIES BY AREA

Area	Number	Percentage
100 acres or more	7	2.34
50 to 99 acres	7	2.34
10 to 49 acres	39	12.77
5 to 9 acres	28	9.35
2 to 4 acres	77	25.4
1 acre or less	144	47.8
	302	100

Some of the nurserymen failed to register before July 1, 1945, and as required by Section 2137 of the General Statutes, were charged for the cost of inspection. Nineteen nurserymen paid this cost and $95.00 has been turned over to the Treasurer of the Station to be sent to the State Treasury. Nurserymen who registered late and failed to pay the cost of inspection and those who neglected to clean up their nursery pests were not issued certificates and therefore cannot legally sell their nursery stock. The cost of inspecting the nurseries, including a few additional visits to see that the pests were properly eradicated, was $1,884.66, exclusive of travelling expenses.

Other Kinds of Certificates Issued

During the year, 146 duplicate certificates were issued to Connecticut nurseries to be filed in other states. Sixty-two dealers' permits were issued to stores and individuals who sell but do not grow their own nursery stock. No inspection is required before issuing these certificates as all dealers are obliged to purchase their plants from certified nurseries. Approximately 70 lots of nursery stock and other plant material were inspected and certified for private individuals. Four hundred and five blister rust control area permits were issued. These permit the planting of currants and gooseberries where there are no timber stands of white pine.

Inspection of Imported Nursery Stock

Certain kinds of foreign nursery stock are allowed to enter the United States at designated ports of entry under permits issued by the Federal Bureau of Entomology and Plant Quarantine. These are released for transit to destination points where they are examined by State inspectors. Most of this nursery stock entering Connecticut consists of rose stocks, which are grafted by florists and are then grown for cut flowers in greenhouses. Since the beginning of the war, the importation of rose stocks has practically stopped, and florists purchase these stocks from the western states. During the past year only one shipment of rose stocks was received from England. This consisted of four cases containing 2,500 plants.

Miscellaneous plant material and seeds are also allowed entry into the United States under the same permit system as above. All this material is sent to Washington, D. C., where it is examined by Federal inspectors and, if found free from injurious insects and plant diseases, it is reshipped to its final destination. None of this material is inspected by State men. This year there was quite a lot of this material, mostly bulbs of flowering plants. Most of it was being sent by members of our Armed Forces who were in Europe.

3,649	Tulip	1	Holly tree
229	Crocus	1	Lilac
172	Narcissus	1	Pine tree
168	Hyacinth	2	Robinsonella cuttings
75	Muscari	13	Miscellaneous shrubs
24	Scilla	7	Boysenberry plants
22	Fritillaria	200	Korean boxwood
3	Iris	435	Strawberry plants
12	Eranthis	30	Raspberry plants
67	Lillium Sp.	2	Grape vines
3	Sprecklia	6	Currant bushes
4,920	Gladiolus	2	Apple trees
6,070	Orchids	1	Pear tree
100	Violets	2	pounds of tree seeds
5	Primula		

QUARANTINE ENFORCEMENT AND MISCELLANEOUS INSPECTIONS, 1945

M. P. Zappe and L. A. DeVaux

Many states have quarantines against various pests in order to protect themselves from damage these might cause if they were introduced from infested states. This, of course, hinders the free movement of plants and plant material. Nurserymen and others who do considerable shipping of this type of material are more or less familiar with the requirements of other states. The average person knows very little about such matters and only hears of them when he or she tries to ship plants from Connecticut to other parts of the country. The United States Postal Department and transportation companies know that it is illegal to accept plants and plant material for shipment unless accompanied by a valid certificate of inspection. We are often called upon to make inspections and furnish certification for such shipments. In some cases we are obliged to refuse certification because the shipment does not comply with the requirements of the state to which it is consigned. Fortunately, most of the requirements of nearby states are such that we can certify the materials, but it is almost impossible to ship certain plants, fruit, etc., into some of the midwestern and western states.

The European corn borer has now spread to such an extent that there are only 21 states that have quarantines of their own preventing importation of susceptible plants unless properly inspected and certified. Of the plants affected by this quarantine, perennials of various kinds and shelled sweet corn are the ones most commonly shipped. A total of 455 European corn borer quarantine inspection tags was issued to certify shipments to these states and Canada. Most of this material was shelled corn being sent to Canada.

The Oriental fruit moth quarantine prevents movement of fruit, used fruit containers and fruit trees. There are five states that still maintain quarantines because of this pest. This material can be

shipped, but it must be fumigated under supervision in an approved fumigation chamber. The cost of the apparatus is so high that no fruit or fruit trees have been treated for shipment from Connecticut into states having such regulations.

Since the establishment of the Japanese beetle and gypsy moth quarantines in Connecticut, this Department has cooperated with the Bureau of Entomology and Plant Quarantine of the United States Department of Agriculture in their administration. The State is divided into two sections, using the gypsy moth quarantine line as a boundary. The section of the State within the gypsy moth quarantined area, which includes Hartford, Middlesex, New London, Tolland, Windham counties, and some towns in northern and eastern Litchfield and eastern New Haven counties, is under the supervision of Mr. H. N. Bartley who is in charge of the federal Japanese beetle and gypsy moth office at Waltham, Massachusetts. His inspectors make the necessary inspections to comply with the Japanese beetle quarantine, and the balance of New Haven and Litchfield counties outside of the gypsy moth quarantined area and the towns of Branford and North Haven in the gypsy moth quarantined area are under the supervision of Mr. M. P. Zappe who is in charge of the New Haven office.

Japanese Beetle

The Japanese beetle quarantine enforcement activities consist of seasonal scouting of certain nursery and greenhouse properties for classification purposes, the inspection and certification of all articles included in the quarantine regulations and other tasks necessary to the operation of the quarantine.

Scouting for adult Japanese beetles has been conducted yearly to determine whether or not beetles were present on classified properties. Because of the decrease in the number of classified areas to be scouted, the district inspectors have performed the scouting activities. Only two certified greenhouses were scouted in the State during the 1945 season. This work was performed by Mr. W. J. Ahearn and Mr. J. F. McDevitt, each having one greenhouse to scout in his area. They began scouting on July 11 and finished September 10, 1945, having examined each greenhouse three times. No beetles were found in either case. There is only one other firm classified in the state, but it does not require scouting as it conducts a mail order business and has neither growing field nor greenhouses.

Inspection and Certification

The total number of plants inspected and certified for shipment to other states and foreign countries was 644,864. The number and kinds of certificates issued are shown in the following table:

TABLE 7. NUMBER OF CERTIFICATES ISSUED, 1945

Kind	Farm products	Cut flowers	Nursery and ornamental stock	Sand soil	Manure	Total
"A"[1]	0	0	4,302	1	0	4,303
"B"[2]	0	0	53	0	0	53
Total	0	0	4,355	1	0	4,356

[1] Used in shipments from nurserymen to customers.
[2] Used between classified nurserymen for carload shipments.

No inspections of farm products and cut flowers were made because no towns in Connecticut are within the area requiring such inspection and certification.

Gypsy Moth

The gypsy moth work consists of the inspection and certification of all materials included in the gypsy moth quarantine regulations, occasional scouting of certain areas in order to issue the necessary certificates, and other tasks necessary to the operation of the quarantine.

The total number of plants inspected and certified for shipment to points outside of the quarantined area was 4,084,981. Forest products inspected and certified totalled 153,426 pieces, 321 cords, 1,722,720 board feet, 1,955 reels and 6,120 bundles. Stone and quarry products amounted to 2,965 tons and 67 pieces. Evergreen products totalled 3,346 bales, 8,981 pieces and 1,135 boxes. The number and kinds of certificates issued are shown in the table below:

TABLE 8. NUMBER OF CERTIFICATES ISSUED, 1945

Kind	Nursery stock	Forest products	Stone and quarry products	Evergreen products	Total
"A"[1]	67,688	554	30	1,741	70,013
"B"[1]	1,387	1,753	83	163	3,386
Total	69,075	2,307	113	1,904	73,399

[1] See footnotes to Table 7.

Miscellaneous

We are also called upon to certify miscellaneous seed shipments to foreign countries as required by the various foreign regulations. Most of these shipments are consigned to South and Central America and Canada with an occasional shipment now and then to European and other countries. During the year 1945, 641 such certificates were used, covering 326 shipments of seeds to South and Central America, Africa and Ireland, and 144 certificates because of the European corn borer were used, covering 72 shipments of seed corn to Canada.

INSPECTION OF APIARIES, 1945

M. P. ZAPPE

During the inspection period of 1945 there was no change in personnel nor in the areas covered by each inspector. Mr. Elbra Baker of Brooklyn works in Tolland, Windham and New London counties. Mr. Roy Stadel of Southington makes inspections in Fairfield, New Haven and Middlesex counties and Mr. W. H. Kelsey takes care of Litchfield and Hartford counties.

At the end of the year Mr. Kelsey resigned due to advanced years and ill health. Mr. Kelsey has been in the service for 11 years, working mostly in the four northern counties. When a third inspector was appointed, the inspection areas were reassigned and Mr. Kelsey had Litchfield and Hartford counties. He has been very faithful and, largely through his efficient work, American foul brood has gradually decreased in his counties. The beekeepers in these counties will miss him as he was always ready to advise them about their bee problems and he was particularly helpful to the beginners in beekeeping. He was President of the Connecticut Beekeepers' Association in 1945 and was re-elected to serve them again in 1946.

Winter mortality accounted for 21.6 per cent of the bees during the winter of 1944-45. This was very much higher than the preceding winter when winter mortality was only 5.44 per cent. There were several reasons for this mortality but, according to inspection reports, it was largely due to starvation. Much of it occurred in the spring and could probably have been prevented by feeding. While the State average was 21.6 per cent, in some counties it was much higher than this figure. Windham County, where 32 per cent of the bees died, was highest, while in Litchfield County it was only 17 per cent.

This season there were 2,589 apiaries inspected in the State, an increase of 138 over 1944, with a total of 13,353 colonies, an increase of 993 colonies from 1944. The average number of colonies per apiary in 1945 was 5.15 as against 5.04 in 1944.

There was a decrease in the amount of foul brood throughout the State. In 1944 it was 3 per cent of all colonies and in 1945 it was found in only 2.23 per cent. Fairfield County still continues to have the greatest amount of American foul brood with New Haven County second. Windham County has the least amount of foul brood but the greatest amount of winter mortality. There was a slight decrease of disease in nearly every county. Most of the diseased colonies of bees were destroyed by burning, either by the inspectors or the owners. A few cases of American foul brood were treated experimentally with sulfathiazole with rather promising results. This will be continued next year on a larger scale. Eventually many colonies of bees may be saved by this treatment, but it is too early to recommend it for general use. One case of European foul brood was found in the town of Orange and one case of sacbrood in Woodbury.

TABLE 9. THIRTY-SIX YEAR RECORD OF APIARY INSPECTION

Year	Number apiaries	Number colonies	Average no. colonies per apiary	Average cost of inspection	
				Per apiary	Per colony
1910	208	1,595	7.6	$2.40	$.28
1911	162	1,571	9.7	1.99	.21
1912	153	1,431	9.3	1.96	.21
1913	189	1,500	7.9	1.63	.21
1914	463	3,882	8.38	1.62	.19
1915	494	4,241	8.58	1.51	.175
1916	467	3,898	8.34	1.61	.19
1917	473	4,506	9.52	1.58	.166
1918	395	3,047	7.8	1.97	.25
1919	723	6,070	11.2	2.45	.29
1920	762	4,797	6.5	2.565	.41
1921	751	6,972	9.2	2.638	.24
1922	797	8,007	10.04	2.60	.257
1923	725	6,802	9.38	2.55	.27
1924	953	8,929	9.4	2.42	.25
1925	766	8,257	10.7	2.45	.22
1926	814	7,923	9.7	2.35	.24
1927	803	8,133	10.1	2.37	.234
1928	852	8,023	9.41	2.12	.225
1929	990	9,559	9.55	2.19	.227
1930	1,059	10,335	9.76	2.01	.206
1931	1,232	10,678	8.66	1.83	.212
1932	1,397	11,459	8.2	1.60	.195
1933	1,342	10,927	8.1	1.69	.208
1934	1,429	7,128	4.98	1.40	.28
1935	1,333	8,855	6.64	1.556	.234
1936	1,438	9,278	6.45	1.429	.221
1937	1,437	10,253	7.1	1.28	.18
1938	1,609	10,705	6.7	1.18	.177
1939	1,627	8,936	5.5	1.12	.204
1940	1,719	8,552	5.0	1.33	.268
1941	2,222	10,720	4.8	1.16	.239
1942	2,354	13,777	5.85	1.18	.201
1943	2,635	14,903	5.65	1.05	.186
1944	2,451	12,360	5.04	1.29	.256
1945	2,589	13,353	5.15	1.21	.235

TABLE 10. INSPECTION OF APIARIES, 1945

County	Apiaries		Colonies		Per cent diseased	Per cent died
	Inspected	Diseased (Am.f.b.)	Inspected	Diseased (Am.f.b.)		
Fairfield	449	67	2,454	142	5.78	19.76
New Haven[1]	356	38	1,918	59	3.07	21.48
Middlesex	154	8	960	9	.93	28.43
New London	321	12	1,694	20	1.18	26.5
Litchfield[2]	334	16	1,785	35	1.96	16.91
Hartford	547	17	2,935	23	.78	17.58
Tolland	216	5	750	8	1.06	23.6
Windham	212	2	857	2	.23	31.98
	2,589	165	13,353	298	2.23	21.62

[1] 1 case of European foul brood, Town of Orange.
[2] 1 case of sacbrood, Town of Woodbury.

TABLE 11. SUMMARY OF INSPECTION

	Apiaries	Colonies
Inspected, 1945	2,589	13,353
Infected with American foulbrood	165	298
Percentage infected	6.37	2.23
Average number of colonies per apiary		5.15
Average cost of inspection	$1.21	$.235
Total cost of inspection, 1945		$3,136.86

TABLE 12. COLONIES WINTER-KILLED, 1945

County	No. of colonies
Fairfield	485
Hartford	516
Litchfield	302
Middlesex	273
New Haven	412
New London	450
Tolland	177
Windham	274
Total winter-killed	2,889

The total cost of inspection varies from year to year. As the number of apiaries and colonies increase, the cost of inspection per apiary and colony is likely to decrease slightly. This was true in 1945.

FINANCIAL STATEMENT
January 1, 1945 — December 31, 1945

Disbursements

January 1 to June 30, 1945:		
Salaries	$ 945.00	
Travel	380.65	
Miscellaneous supplies	27.16	
		$1,352.81
July 1 to December 31, 1945:		
Salaries	$1,162.50	
Travel	621.55	
		1,784.05
Total disbursements for 1945		$3,136.86

Registration of Bees

Section 2129 of the General Statutes provides that each beekeeper shall register his bees on or before October 1 of each year with the town clerk of the town in which the bees are kept, and that each town clerk on or before December 1 shall report to the State Entomologist whether or not any bees have been registered and, if so, shall send a list of names and number of colonies belonging to each registrant.

In 1945, 2,589 apiaries containing 13,353 colonies were inspected. However, only 1,781 apiaries were registered. This shows that 808 more apiaries were inspected than were registered by the town clerks. No doubt some unregistered apiaries were not inspected by the apiary inspectors who did not know of their existence. Uninspected bees may be a source of foul brood infection for other bees in the community. Every effort is being made to have all beekeepers register their bees so that they may be inspected and treated if found diseased.

GYPSY MOTH CONTROL

O. B. Cooke[1] and R. B. Friend

Gypsy moth control work was carried on with the force available the past year. Some employees of this Department were still serving in the armed forces of the country and a few members were still on leave of absence from the Department, having accepted employment with concerns engaged in war production work. Type mapping (a description of which is given in the Connecticut State Entomologist's Report, Bul. 445, year 1940) was performed in the towns of Mansfield, Somers, Vernon and Winchester. Some scouting work was performed during the winter months in areas in and around nursery plots in the towns of Cromwell, Middlefield and Rocky Hill, and in previously known heavily infested areas in the towns of Ellington, Manchester, South Windsor and Vernon. All egg masses found were destroyed with creosote.

Defoliation and Susceptible Areas

An extensive survey for defoliation caused by the gypsy moth was made during the summer months in all towns in New London, Hartford, Tolland and Windham counties and in some towns in Middlesex, New Haven and Litchfield counties. The results of this survey show that there was some defoliation in Connecticut but not to such a degree as to cause alarm. Most of the defoliation was confined to individual trees, a large number of which were located in the central northern section of the State.

If we take the observed amount of defoliation as a criterion of the abundance of this insect and, hence, of the relative degree to which the environment favors it, the estimates made in 1945 are of considerable interest. The total area defoliated in each of the three southern and in all six New England states in 1945 is given in Table 13 below. This represents the greatest amount of defoliation in the history of the gypsy moth in this country. The defoliation in Connecticut was remarkably light and of no great economic significance. The distribution of the defoliated areas may be of some significance in relation to those parts of southern New England where outbreaks

[1] Major O. B. Cooke has been Deputy in Charge of Gypsy Moth Control work since November 16, 1945, when he returned to State employ from the United States Army.

Table 13. Defoliation Caused by the Gypsy Moth in New England in 1945

	Acres defoliated				
	25%	50%	75%	100%	Total
Massachusetts[1]	102,695	104,350	92,474	157,313	456,832
Rhode Island	280	200	350	450	1,280
Connecticut[1]	5	4	2	5	16
All New England	298,692	225,566	132,470	164,748	821,487

[1] The total area of Massachusetts is 8,029 square miles, that of Connecticut is 4,820 square miles.

of the insect are likely to occur. A belt of towns extending from Dartmouth in southeastern Massachusetts northward through Bristol County and Norfolk County, thence westward through Worcester County into Hampshire and Franklin counties suffered most. In each of these towns the trees on 500 or more acres were completely defoliated. Relatively little defoliation occurred in those towns in Massachusetts situated along the northern border of Connecticut.

The above mentioned Massachusetts towns where the gypsy moth outbreak was so intense, with the addition of extensive areas in Plymouth and Barnstable counties (not so seriously affected in 1945), represent a general area highly susceptible to gypsy moth attack. Just why the insect is not more abundant in Connecticut is not quite clear. Unpublished work of Bess of the federal Bureau of Entomology and Plant Quarantine indicates that the nature of the site, rather than the species of trees (in regard to food plants of the insect) present, may well be of great significance in the relation to the effect of the environment on gypsy moth abundance. These site factors which are correlated with a high mortality of larvae appear to operate strongly in this State.

This favorable condition, as indicated by the absence of extensive outbreak areas, may operate through much of Connecticut. The scattered distribution of defoliated trees is shown by an analysis of the defoliation in 1945. In 30 towns extending south to Rocky Hill, the trees on one-tenth of an acre or more were stripped of foliage. In only four towns did defoliation extend over one acre in toto. The data for these four is given in Table 14 below. The gypsy moth has been present in Connecticut about 40 years and has been found west of the Connecticut River about 24 years. In that period only two extensive outbreaks have occurred, one involving about 30 acres at Groton in 1933 and one involving about 1,500 acres in Granby and vicinity in 1938 and 1939. It may be premature to rely on this record

Table 14. Gypsy Moth Defoliation in Connecticut, 1945
Towns with 1 acre or more defoliated

Town	Number of acres defoliated				
	25%	50%	75%	100%	Total
Burlington	0	0.1	0.25	1.4	1.75
Granby	1.5	0	0.2	2.1	3.8
Hartland	0.8	1.0	0	0	1.8
New Hartford	0.4	0	0.8	0.4	1.6

as an indication of what will happen in the future, but to date the record has been good and forms a basis for our control operations.

That part of the State most favorable to the development of gypsy moth outbreaks appears to lie in Hartford and Litchfield counties. This is based on the records of past infestations and the present status of the insect, as well as on the abundance of oak trees in the forests. The four towns listed above are in this area. At the present time an area of about 200 acres in Barkhamsted and about 70 acres in West Hartford and Farmington are heavily infested and should be treated with insecticides in 1946 to prevent severe defoliation.

In New England the federal Bureau of Entomology and Plant Quarantine reports that, in general, in spite of starvation and wilt disease in the intensely infested areas in 1945, there are more egg masses at present (fall of 1945) than there were in the fall of 1944.

Spraying

A spraying program was set up and carried to completion insofar as was possible during the spring and early summer with the equipment, men and time available. In all, 38 infested trees and areas were sprayed with mixtures containing either DDT, cryolite or arsenate of lead. The four largest infested areas, all woodland, one of five acres, one of 10 acres and one of 20 acres located in the town of Barkhamsted, and one of 24 acres located in the town of Granby, were sprayed with a helicopter that was loaned to us by the U. S. Coast Guard.

The treatments applied by the helicopter were effective in three of the four areas, as indicated by the number of old and new egg masses found in the fall of 1945 (Table 15). All areas were sprayed during the last week in May or the first three weeks in June with a solution of one pound of DDT in a mixture of one quart of xylene and three quarts of kerosene, applied at the rate of one gallon (one pound of DDT) per acre. The entire Granby area was not examined for egg

TABLE 15. GYPSY MOTH CONTROL — HELICOPTER — 1945

Area	Date sprayed	Egg masses found, fall 1945	
		1944 e.m.	1945 e.m.
Granby, 24 acres	June 19, 1945	47	164[1] 287[1]
Barkhamsted, 5 acres	May 30, 1945	156	6
Barkhamsted, 10 acres	June 19, 1945	97	5
Barkhamsted, 20 acres	June 19, 1945	498	1

[1] See text.

masses, so the figures in the table represent those found in a strip along each side of the road running through the plot. In one strip, 47 old (1944) egg masses were found and 164 new (1945). The old egg masses were not counted in the other strip. The reason for failure

in this plot may lie in either the relatively high wind which blew the insecticide off the plot or inability of the pilot to locate the markers with a consequent application at the wrong place.

The helicopter has many good attributes in spraying forest trees but, in its present state of development, it does not appear to be as useful as a standard type winged plane for this purpose. The model we used (not the latest) had too small a carrying capacity, about 30 gallons being the maximum load. The biplanes used by the federal Bureau of Entomology and Plant Quarantine carried a load of 75 to 100 gallons. These were small but maneuverable and had the necessary reserve power. They were equipped with either a spinner disk dispersing apparatus or a series of nozzles on a boom. At a speed of 80 miles per hour, they could spray 16 acres a minute, applying one gallon per acre. One of these planes actually treated 625 acres in one morning. The cost, exclusive of depreciation on equipment, was about two dollars per acre. With an orthodox ground spraying apparatus, the cost, including depreciation, would be about 20 dollars per acre. A dose of one pound of DDT per acre will practically eliminate the gypsy moth from an area, and one-half pound per acre will give excellent control.

Mr. Randall Latta of the Bureau of Entomology and Plant Quarantine carried out a series of experiments with a DDT emulsion applied with a Hochberg-LaMer aerosol generator. Several large infested oaks and strips of woodland in Connecticut were treated for the control of larvae. Mr. Latta's report has not been published, so the results cannot be given here.

The federal Bureau of Entomology and Plant Quarantine, as in the past, performed extensive gypsy moth control work in the western part of Connecticut during the year. In Litchfield and New Haven counties, the Bureau sprayed 45 infested areas with 1,786 pounds of insecticides (DDT, cryolite, or arsenate of lead). A small number of burlap bands were applied to trees at infested areas in the towns of Canaan, Salisbury and Sharon.

There are factors aside from the control of pests to be considered in applying DDT over large areas, as the danger to man and domesticated animals, to wild animals other than insects and to useful insects. According to a recent press release by the United States Department of Agriculture, no case of poisoning to man or domesticated animals by DDT has been called to their attention. The effect of this insecticide on mammals is less severe than that of nicotine or lead arsenate.

As for the effect on wild animals and useful insects, the use of DDT in forested areas at the doses employed will probably not be so injurious as at first anticipated. Doses of one pound per acre or less do not seriously affect birds but may be harmful to fish. As for insects other than those the DDT is intended to kill, the comments of

Dr. C. T. Brues[1] who, at the request of the National Audubon Society, investigated the deleterious effects of DDT on an area sprayed for gypsy moth control, are interesting. Brues confined his observations to the effect on the general insect fauna on an area of about 50 acres near Athol, Mass., sprayed with 1.43 pounds of DDT per acre by the Bureau of Entomology and Plant Quarantine on June 2, 1945. Insects were collected up to September 9 in this area and in two others nearby which were infested but not sprayed. The gypsy moth was completely controlled in the sprayed area and the foliage remained normal. There was almost complete defoliation in the two unsprayed areas. Throughout the summer other insects were more abundant in the sprayed plots than in those not treated. Brues attributes this to the preservation of the normal forest environment in the former, whereas in the latter much of the canopy was removed by the leaf-eating caterpillars.

As for egg parasites, the federal Bureau collected three egg masses of the current year in a sprayed area in the Wendell Forest, Massachusetts. The eggs were fertile and were parasitized by *Anastatus bifasciatus* to the extent of 22 per cent, 30 per cent, and 32 per cent, respectively.

Survey for Infestations

For the past few years and again this year, the State gypsy moth force has assisted the federal Bureau of Entomology and Plant Quarantine in a gypsy moth sex attractant survey. During July and August, 1945, members of this Department placed and patrolled 481 traps in various locations in the following towns in Connecticut: Bridgewater, Brookfield, Middlebury, Monroe, Newtown, Oxford, Roxbury, Shelton, Southbury and Woodbury.

The federal Bureau placed traps in Sharon and New Haven. In all 12 towns, 189,324 acres were involved. The results, taken from the Annual Report for 1945 of the Division of Gypsy and Brown-tail Moths Control of the Bureau, are given in Table 16 below. Sharon is in the Barrier Zone and has been infested for a number of years. Only six moths were caught in the rest of the area. Two of these were in New Haven at the site of a previous infestation.

Between July 1, 1944 and June 30, 1945, the federal Bureau surveyed with ground crews 18 towns in Litchfield County and four towns in New Haven County, all in the Barrier Zone and all of them likely to be infested. Ninety-eight per cent of the 60,000 acres surveyed was in Litchfield County. One hundred-seventeen infestations containing over 48,000 egg masses were found. In Litchfield County 10 or more infestations were found in each of the following towns: Canaan, Cornwall, Litchfield, North Canaan, Sharon and Warren. In New Haven County no infestations were found in Middlebury and Southbury, but one infestation containing one egg mass

[1] See Annual Report for 1944, Division of Gypsy and Brown-tail Moths Control, Bureau of Entomology and Plant Quarantine, U. S. D. A.

was found in New Haven and one containing 21 egg masses was found in Wallingford. Both these last two infestations were in localities previously known to be infested. Only restricted areas were surveyed in New Haven County.

TABLE 16. TRAPPING SURVEY, CONNECTICUT, 1945

Town	Acres involved	Number of traps used	Number of traps in which moths were caught	Number of moths caught
Sharon	38,819	140	66	165
Newtown	38,664	110	2	2
Southbury	25,818	85	0	0
Oxford	23,035	62	0	0
Shelton	19,978	62	1	1
Monroe	15,200	45	0	0
Woodbury	7,781	33	1	1
Roxbury	5,842	15	0	0
Brookfield	4,250	10	0	0
Middlebury	4,160	15	0	0
Bridgewater	3,400	15	0	0
New Haven	2,377	15	1	2
Total	189,324	607	71	171

The gypsy moth was more abundant in 1945 than in the previous year, especially in the northwestern part of the State. Thanks to the federal Bureau, which carries out control operations in the Barrier Zone, the situation there is not alarming at the present time.

Hatching of Eggs

As an aid in determining the trend of the gypsy moth population within the State, egg masses are collected each year in the early spring, held outdoors until the eggs hatch, then the numbers of hatched and unhatched eggs in each mass are counted to obtain the percentage of hatch. The results obtained this year are listed below:

Number of egg masses collected	115
Number of eggs per mass	705
Number of eggs hatched per mass	412
Per cent hatched	58.5

In the New York-New England area, in general, the hatch was 65 per cent, as determined by the federal Bureau. In the vicinity of Greenfield, Mass., eggs began to hatch April 7 and, by April 19, 50 per cent of the eggs had hatched in Massachusetts, two weeks earlier than normal.

The Division of Gypsy and Brown-tail Moths Control of the federal Bureau of Entomology and Plant Quarantine cooperates with this office in control work in Connecticut. We take this opportunity to express our appreciation to R. A. Sheals, Chief of the Division, and to S. S. Crossman and H. L. Blaisdell, Assistant Chiefs.

SPREAD OF THE DUTCH ELM DISEASE IN CONNECTICUT

M. P. Zappe

The Dutch elm disease was first found in Greenwich in 1933. Since then the disease has spread to the east and north and in 1945 it was found present in each county. In the eastern part of the State it is still rather scarce, as it has only recently reached that region. In the areas where it has been present for several years it is causing considerable loss of elms. This is particularly true of Fairfield and New Haven counties. Some of the towns have consistently removed diseased trees as soon as they are found. In these towns the tree wardens make regular inspections of the elm trees. Many of the towns remove diseased trees from private property to safeguard trees on other property and on town highways. Conditions in some of the towns are very serious, as they have lost many elms.

Each diseased tree left after the bark beetles emerge is a potential source of infection for other trees. These trees are often left due to neglect, lack of funds for their removal, or shortage of available help, particularly tree climbers.

The Bureau of Entomology and Plant Quarantine no longer carries on control operations in the older infected territory. Its activity is confined to scouting for trees in the newly infected areas. This is a zone east of the Connecticut River and to within 10 or 15 miles of the Rhode Island line, part of it infected and part of it comprising a 20-mile-wide border zone. When diseased trees are found, they are reported to the State Entomologist's office and we, in turn, notify the authorities in the town where the trees are located. The exact location of the diseased tree is given and the authorities are urged to remove it without delay, pointing out the fact that, if it is left, it may result in further spread of the disease in their town.

The United States Department of Agriculture scouts reported 160 diseased elms east of the Connecticut River during 1945. Thirty-six of these were located in 16 towns where the disease was not known to be present before this year. These are as follows: Westbrook, Old Saybrook, Essex, Waterford, New London, Montville, Norwich, Lisbon, Colchester, Lebanon, Marlborough, Hebron, Windham, Chaplin, Mansfield and Somers. The conditions in East Hartford, Glastonbury and Portland are particularly bad as 18 diseased trees were reported in 1945 in East Hartford, 28 in Glastonbury and 43 in Portland. The first diseased elms were found in East Hartford and Glastonbury in 1944 and in Portland in 1942.

The European bark beetle, *Scolytus multistriatus* Marsh., the principal vector of Dutch elm disease, has been known to be present in the above area for several years. Large numbers of this beetle may account for the abnormally rapid rise of the disease in these towns. During 1943 and 1944 we attempted to trap Scolytid beetles in trap logs in the area east of the Connecticut River in order to find out if any beetles have been collected in all towns where the Dutch elm disease has appeared. We also have records of its occurrence beyond the limits of known Dutch elm disease locations. Apparently, the beetles are spreading toward the east, followed closely by the Dutch elm disease.

DUTCH ELM DISEASE IN SOUTHWESTERN CONNECTICUT

John C. Schread, Philip P. Wallace[1] and George A. Zentmyer[2]

Since 1942 a study of the development of the Dutch elm disease, *Graphium ulmi*, in the southwestern part of Connecticut has been carried on. Five one-half mile square plots were laid out in each of the following four towns in Fairfield County that year: Greenwich, Stamford, Darien and Norwalk.

During July of each year since 1942, the plots have been scouted and samples taken to determine the degree of spread of the disease in the elm trees in the plots. Table 17 gives a summary of the results of this work for the past four years. It can be seen that the number of diseased trees has varied from year to year in any single plot and from plot to plot, there being an increase in some years and a decrease in others. The plots in Stamford have shown consistently a more rapid increase in the number of diseased trees each year, especially so in plot 1. From 1942 through 1944 the increase in this town was very rapid. However, in 1945 there was a 31.85 per cent decline in the number of diseased trees found in these plots. In the five plots in Greenwich the number of diseased trees more than doubled from 1944 to 1945, but the actual number of diseased trees is not great. In the Darien plots the total number of diseased trees increased 84.37 per cent from 1944 to 1945, while in the Norwalk plots there was a 33.33 per cent decrease in diseased trees located.

Table 18 gives the total percentage of trees from *Graphium ulmi* in the five plots in each town and the number of diseased trees per square mile of all plots in their respective towns. On a basis of the number of square miles in each town, a total estimated number of diseased trees for each town has been figured and is shown in the table. This estimate is not very precise, for we do not know how many diseased trees have been removed in each town.

[1] Now with Monsanto Chemical Co., St. Louis 4, Mo.

[2] Formerly plant pathologist, Connecticut Agricultural Experiment Station; now plant pathologist, Citrus Experiment Station, Riverside, Calif.

TABLE 17. DUTCH ELM DISEASE SUMMARY, 1942 THROUGH 1945, SHOWING THE NUMBER OF TREES DISEASED IN EACH OF 20 PLOTS OVER A PERIOD OF FOUR YEARS IN FOUR TOWNS IN CONNECTICUT

Town	Sq. miles scouted	Town area sq. miles	No. elms estimated In plot	No. elms estimated In town	Diseased trees in plots[1] 1942	1943	1944	1945
Greenwich								
1	.24		592		5	5	3	7
2	.31		387		..	..	..	4
3	.25		194		..	..	..	1
4	.20		242		3	..	1	1
5	.15		235		3	1	2	0
Total	1.15	42.7	1,650	61,215	11	6	6	13
Stamford								
1	.27		375		9	25	111	52
2	.26		250		6	2	..	9
3	.25		379		3	11	11	23
4	.25		213		1	5	9	2
5	.25		224		0	7	4	6
Total	1.28	38.1	1,441	42,798	19	50	135	92
Darien								
1	.20		215		6	8	5	6
2	.25		217		7	5	6	4
3	.25		239		1	4	14	30
4	.27		359		5	7	5	19
5	.25		90		1	0	2	0
Total	1.22	14.9	1,120	13,664	20	24	32	59
Norwalk								
1	.22		234		1	1	..	2
2	.21		226		3	3	30	15
3	.20		613		1	4	2	0
4	.23		40		0	2	..	2
5	.18		70		5	2	4	5
Total	1.04	24.6	1,183	27,993	10	12	36	25

[1] The data in this and the following table represent trees diseased the year indicated. Trees which were recorded in previous years are *not* included.

TABLE 18. PER CENT DISEASE OF TOTAL ELMS IN PLOTS AND NUMBER OF TREES DISEASED PER SQUARE MILE OF PLOTS AND TOWNS

		Greenwich	Stamford	Darien	Norwalk
Graphium ulmi, per cent of total elms in plots	1942	.66	1.38	1.78	.84
	1943	.36	3.46	2.14	1.01
	1944	.36	9.36	2.85	3.04
	1945	.78	6.38	5.26	2.02
Graphium ulmi per square mile of plots	1942	9.6	15.0	16.0	9.6
	1943	5.2	39.0	19.7	11.5
	1944	5.2	105.4	26.2	34.6
	1945	11.3	71.8	48.3	23.0
Total estimated *Graphium ulmi* in town	1942	408	564	244	236
	1943	223	1,485	292	283
	1944	223	4,006	391	851
	1945	482	2,735	719	565

MOSQUITO CONTROL IN 1945

R. C. BOTSFORD, Agent
State Board of Mosquito Control

Mosquito suppression work by the Board was carried on by authority of Sec. 2416 of the General Statutes as usual. Only three laborers were available, but the four foremen also cleaned ditches, dug out closed outlets, oiled certain areas and patrolled and inspected salt marshes as far as time would permit. Work was concentrated on areas known to be highly dangerous and this prevented large scale breeding. Salt marsh areas where major repairs are required to prevent flooding were omitted from this season's work. It would not be economical to reditch the damaged areas until repairs to dikes or tide gates are completed.

Funds were granted by the Legislature for certain major repairs, the status of which is outlined below.

The new tide gate on Sybil Creek at Indian Neck, Branford, which prevents the flooding of 89 acres of salt marsh, was completed and some of the ditches were recut.

Engineering plans for a new tide gate on a proposed bridge at Beach Park Road in Clinton are completed. The condition of more than 200 acres of salt marsh in poor condition can be corrected by this construction.

The outlet to Rusby Meadow in Westbrook was repaired and reinforced by concrete.

Repairs to Stony Creek Dike in Branford, protecting 63 acres of salt marsh, were completed.

Engineering work on the construction of the Great Harbor Dike protecting 200 acres in Guilford, the Indian River Tide Gate protecting over 50 acres in Clinton, and repairs to the Farm River Tide Gate are in progress.

The condition of the Hammock River marsh of more than 100 acres north of Post Road, Route No. 1, Clinton, poorly drained, cannot be corrected until the proposed tide gate at Beach Park Road is installed.

Mosquitoes originating from fresh water areas were reported to be abundant this season. Fresh water mosquito control is considered a local problem in that the species do not migrate any great distance from their breeding places as do the salt marsh species. This Board does not include the control of fresh water species in its regular control program, but will give aid to any organized effort in the line of technical advice and field surveys as time permits. Fresh water areas are defined as any mosquito breeding places beyond the reach of nor-

mal high tides. Usually in swampy places, these may be determined by the type of vegetation.

No surveys of inland areas were made this year but several towns made use of information we had accumulated in the 1944 surveys which had been forwarded to the health officers. Among these towns were Bristol, New Britain, Plainville, Newington and East Hartford.

The abundance of mosquitoes in some localities brought forth many inquiries concerning the application of larvicides by airplane and the use of repellents. The new repellents when properly applied will keep mosquitoes away for several hours and are a great convenience at times.

Present repellents will probably never take the place of eliminating mosquitoes at their source. Larvicides and insecticides spread by airplanes over large areas are effective but, under certain conditions, as yet, too expensive for general use.

The use of DDT as an insecticide made possible the enjoyment of six outdoor concerts in the Yale Bowl last season without mosquito annoyance. Previous to treatment, mosquitoes were plentiful and were biting at the rate of about five per minute. The DDT was applied by spraying with a helicopter and also by fogging with power mist blowers. This work was experimental and carried out to test methods of application. The DDT solution was made up according to the following formula: DDT one pound, xylene one quart, kerosene three quarts.

The first spraying of the Yale Bowl was made by helicopter on July 5, including the city block and some of Edgewood Park. About 85 acres were covered and about 95 gallons of mixture used. Mosquitoes were entirely absent for about 5 days, then reappeared in small numbers, requiring re-spraying before the next concert. Sprays were applied a day or two before each of the four following concerts by power blower, covering only the inside of the Bowl and seat area and the outside of the Bowl inside of the fence, about 20 acres. The sixth and last concert was treated August 29 by helicopter, spraying the Bowl and immediate outside area.

The same DDT formula was applied by power blower to a residential area of about 14 acres in Farmington and a similar area in Wethersfield. In all cases adult mosquitoes were eliminated for a period of eight to 12 days, after which time mosquitoes gradually increased in abundance.

The work plans for next season, in addition to the patrol of the marshes and cleaning of ditches, will include the construction of two tide gates in Clinton; reconstruction of the dike and tide gate at Great Harbor, Guilford; and repairs to the Farm River tide gate in East Haven. Also, further trials will be made with DDT.

SPRAYING WITH A HELICOPTER[1]

Many types of apparatus for applying insecticides have been tested in recent years, and one of the most interesting of these is the

Figure 5. Upper: Helicopter spraying an orchard at Middlefield, Conn. Lower: Spray boom on helicopter.

[1] The general supervision of this work as it concerned our staff was under the direction of Mr. M. P. Zappe. Mr. Turner assisted on the potato spraying experiment; Mr. Plumb, on those connected with the European pine shoot moth and pine sawfly; Dr. Garman, on those concerned with apple maggot and 17-year locust; and Mr. Schread, on those involving Japanese beetle.

helicopter. During the summer of 1945 we were fortunately able to cooperate with the Coast Guard and the Federal Bureau of Entomology and Plant Quarantine in investigating its practicability. The Coast Guard furnished a Sikorsky model Y. R. 4 which had been converted from a trainer. It was equipped with a 30-gallon tank and a pump that would discharge 2.85 gallons of spray per minute at 75 pounds' pressure and 3.95 gallons per minute at 150 pounds' pressure. In the experiments carried out in Connecticut, 150 pounds' pressure was always used. The spray boom under the tail carried 20 ¼ TT8001 nozzles with an orifice diameter of .02 inch. The craft flew 20 to 40 feet above the trees or, in the case of field crops, above the ground, at a cruising speed of 50 to 60 miles per hour.

Most of the spraying operations were carried out early in the morning just after dawn. There is usually little or no wind at this time and thermal currents are absent. Early morning mists sometimes caused a slight delay.

The spray formula used on most plots was one pound of DDT, one quart of xylene, and kerosene to make one gallon. Variations of this were used on a few plots. The rate of application was usually one gallon per acre. Clean glass plates were placed on the ground in the plots before spraying to give an indication of spray deposit and distribution. Examination of these plots immediately after spraying showed a good deposit, even in woodland areas where there was a dense canopy of foliage. Pieces of white cotton cloth, one yard square, pegged to the ground so as to catch insects killed by the spray, gave some indication of its effectiveness.

Since the main object was to determine whether or not the helicopter showed promise as a spraying machine to apply concentrated insecticides in small amounts per acre, a number of plots, most of them five acres or more in area, having different types of insect infestation, were treated. Only a rough approximation of the effect of the insecticide was possible. Difficulties in arranging and carrying out a proper schedule of treatments were encountered, but these are inherent to any such operations.

Those who were responsible for the operations in the field deserve the highest praise. The pilot of the helicopter, Ensign David Gershowitz of the Coast Guard, carried out all assignments enthusiastically and on schedule. Undoubtedly that rabbit's foot in his pocket kept him free of trouble. Aviation Mechanic (1st Class) Roy Wagner of the Coast Guard, to whom the working parts of a helicopter are an open book, saw to it that no mechanical difficulties were encountered. Lieutenant J. S. Yuill of the Navy, an entomologist of high repute in civil life, was chief coordinator for the Navy and the Federal Bureau of Entomology and Plant Quarantine. John V. Schaffner, Jr., of the Federal Bureau of Entomology and Plant Quarantine, and members of the Station staff carried out the entomological operations.

The extent of operations is shown in the table below.

TABLE 19. HELICOPTER SPRAYING, 1945

Date		Host	Insect	Town	Acres sprayed	DDT per acre
May	22	Apple	Cankerworms	Branford	5	1 lb.
	22	Apple	Cankerworms	Branford	5	2 lbs.
	22	Apple	Cankerworms	Branford	5	½ lb.
	24	White pine	Pine bark aphis	Hamden	5	3 lbs.
	24	Oak	Cankerworms	North Haven	10	2 lbs.
	25	Oak	Cankerworms	Hamden	10	3 lbs.
	25	Oak-Maple	Cankerworms	Hamden	10	1 lb.
	25	Elm-Maple	Cankerworms	Cheshire	5	1 lb.
	29	Elm	Cankerworms + Scolytus	Portland	5	2 lbs.
	29	Elm	Cankerworms + Scolytus	Portland	5	4 lbs.
	29	Elm	Cankerworms + Scolytus	Portland	5	8 lbs.
	30	Oak-Birch-Poplar	Gypsy moth	Barkhamsted	5	2.4 lbs.
	30	Oak	Gypsy moth	Bloomfield	1	1 lb.
	31	Apple	17-yr. cicada	Middlefield	5	3 lbs.
	31	Apple	17-yr. cicada	Middlefield	5	2 lbs.
	31	Apple	17-yr. cicada	E. Wallingford	5	3 lbs.
June	19	Woodland	Gypsy moth	Barkhamsted	10	1 lb.
	19	Woodland	Gypsy moth	Barkhamsted	20	1 lb.
	19	Woodland	Gypsy moth	Granby	24	1 lb.
	19	White Oak	Gypsy moth	North Granby	isolated trees	1 lb.
	21	Woodland and Pond	General effect	Farmington	5	1 lb.
	21	Red Pine	European pine shoot moth	Southington	5	1 lb.
	22	Red Pine	*Diprion frutetorum*	Branford	5	1 lb.
July	3	Potato	Potato insects	Cheshire	10	1 lb.
	4	Potato	Potato insects	Ellington	10	1 lb.
	4	Potato	Potato insects	Ellington	10	1 lb.
	4	Potato	Potato insects	East Windsor	10	1 lb.
	4	Potato	Potato insects	Manchester	10	1 lb.
	5	Yale Bowl	Mosquitoes	New Haven	83	1 lb.
	11	Potato	Potato insects	Cheshire	20	1 lb.
	11	Apple	Apple maggot	Meriden	5	1 lb.
	11	Birch	*Fenusa pusillus*	Cheshire	5	1 lb.
	12	Potato	Potato insects	Ellington	20	1 lb.
	12	Potato	Potato insects	Ellington	10	1 lb.
	12	Potato	Potato insects	East Windsor	10	1 lb.
	12	Potato	Potato insects	Manchester	10	1 lb.
	12	Potato	Potato insects	Ellington	8	1 lb.

TABLE 19. HELICOPTER SPRAYING, 1945—(Concluded)

Date	Host	Insect	Town	Acres sprayed	DDT per acre
August 8	Potato	Potato insects	Cheshire	20	1 lb.
8	Apple	Apple maggot	Meriden	5	1 lb.
13	Potato	Potato insects	Ellington	20	1 lb.
13	Potato	Potato insects	Ellington	10	1 lb.
13	Potato	Potato insects	East Windsor	10	1 lb.
13	Potato	Potato insects	Ellington	10	1 lb.
13	Woodland	Japanese beetle	Bloomfield	5	1 lb.
28	Woodland	*Anisota senatoria*	East Lyme	5	1 lb.
28	Woodland	*Anisota senatoria*	East Lyme	5	½ lb.
28	Woodland	*Anisota senatoria*	East Lyme	5	¼ lb.
29	Yale Bowl	Mosquitoes	New Haven	50	1 lb.
31	Pine	*Diprion frutetorum*	Litchfield	6	1 lb.
31	Pine	*Diprion frutetorum*	Litchfield	16½	½ lb.
31	Pine	*Diprion frutetorum*	Litchfield	5	¼ lb.
31	Pine	*Diprion frutetorum*	Litchfield	5	⅛ lb.

Cankerworms

Several plots were sprayed for the control of cankerworms, including an orchard in Branford and woodland areas in North Haven and Hamden. Various amounts of DDT were used, from one-half to three pounds per acre. Due to lack of sufficient help, it was impossible to get detailed results from all plots, but it was estimated that about 80 per cent control was obtained on plots that were sprayed with DDT at the rate of one pound per acre. In the orchard at Branford, where cankerworms were particularly abundant, counts of dead and dying larvae on cloth screens one yard square in area showed an average of about 275 per screen.

The adjacent plots of five acres each in Portland were sprayed for cankerworms and the smaller European bark beetle with 2, 4 and 8 pounds of DDT per acre. It was not possible to get any information on effect of the spraying on the above mentioned insects. Dr. S. C. Ball, Curator of Zoology at the Peabody Museum, visited the plots two weeks after spraying to determine the effect on bird life. As these plots were sprayed with comparatively heavy doses of DDT, harmful effects on bird life should be evident here, if anywhere. After examination of the plots and intermediate areas, Dr. Ball concluded that the birds were not seriously affected.

Pine Bark Aphid

A five-acre plot of white pine in the Sleeping Giant State Park in Hamden heavily infested with pine bark aphids, was sprayed on May 24. An examination of the plot later in the season disclosed that the infestation had been nearly exterminated and it was believed that

the spray was effective; however, in a check plot one-fourth mile away the infestation was also reduced, probably due to natural causes. The caretaker stated that flies and mosquitoes that were usually abundant in the area were notably missing for several weeks after spraying.

Gypsy Moth

Several areas were sprayed for the control of the gypsy moth, and the results in general were excellent (see pages 28-29).

Periodical Cicada

As the periodical cicada was in the adult stage in Connecticut this summer, we had an opportunity to try DDT on this insect. At Middlefield 10 acres of orchard were sprayed with the helicopter and five acres in East Wallingford. Spraying conditions were good, and examinations were made at intervals for several days after the spraying. Apparently, the cicadas were not injured in the least by the DDT as no dead individuals were found. A number were collected after spraying and placed in insect cages where they lived for 10 days before any died.

General

An area of five acres in Farmington was sprayed with the aim of determining the effect of this dose of DDT on animal life in general. We were unable to examine the area suitably after treatment.

European Pine Shoot Moth

Spraying was carried out on a block of four to five acres of pure red pine about eight feet in height on the watershed of the Shuttle Meadow Reservoir, Southington. These trees were heavily infested with the European pine shoot moth. The moths had been emerging previous to June 21 and many females were in evidence. A count was made on July 27 of the spring-infested tips on 21 trees, and of both spring- and summer-infested tips on six trees. The spring-infested tips numbered 46.8, the summer-infested tips 102.2, per tree. Previous figures obtained for the average number of tips on a tree of a given height indicate 104 for an eight-foot tree. In arriving at this figure only the tips on the upper six feet were included. The counts made at Southington are comparable, however, since the lower two or three whorls had been removed by pruning.

The date of application was made too early, as insecticides are usually applied later in June and early in July. The DDT mixture (12.5 per cent) applied at the rate of one pound per acre obviously failed to kill the moths, nor did it exhibit any residual effect upon the newly-hatched larvae. Lack of residual effect may have been due to one or more of several factors of toxicity, persistence and coverage.

Sawfly on Red Pine

The area treated June 22 at Rose Pond, Branford, included the major part of a pure block of red pine, planted in 1922. This plantation is approximately 20 acres in size and the trees now average about 25 feet in height. For the past several years the south-central portion of the stand has been heavily defoliated by larvae of *Diprion frutetorum* and *Lambdina athasaria* var. *pellucidaria*. The crowns of the trees were so thinned in parts of the infested area that a dense ground cover has appeared. This defoliation, supplemented by attacks of secondary insects and a severe drought in 1944, has caused the death of numerous trees. Still others appear not likely to survive.

Although there was an extensive flight of moths in 1944, very few larvae of *Lambdina athasaria pellucidaria* were observed feeding in 1945. Sawfly larvae also appeared to be scarce. However, the block was sprayed with a 12.5 per cent solution of DDT. Boundary flags had been placed to delineate the area to be treated, but wind-drift caused unintentional coverage of approximately the entire block. Cloth trays three feet square were placed on the ground at strategic points throughout the plantation previous to spraying. The trays were collected on June 27, 1945, and a count was made of the dead larvae and miscellaneous invertebrates found on them (see Table 20).

A study of the map of the area and of the table indicates that the sawfly infestation is moving in a north-westerly and north-easterly direction from the original center. This will involve portions of the stand hitherto very lightly infested or apparently uninfested. The count of sawfly larvae by instars shows that 62 per cent were in the second instar. The first, second, and third instars included 96.6 per

TABLE 20. DEAD AND DYING LARVAE ON TRAYS. ROSE POND, BRANFORD

Tray No.	*Diprion frutetorum* by instars						*Lambdina athasaria*
	1	2	3	4	5	Total	
1	2	15	11	1		29	
2	1	17	2	3	1	24	3, 1st instar
3	2	30	1	1	1	35	3, 1st instar
4	17	34	10			61	3, 1st instar
5	14	25	3			42	
6		7		1		8	
7		14	5	1		20	
8		4				4	1, 1st instar
9 and 10	3	20	11			34	2, 1st instar
11	1	6	6	1	1	15	2, 1st instar
12 and 13	3	23	4	1	2	33	
14 and 15	21	39	5			65	2, 1st instar
16	4	14		1		19	
17		1	4		5	1	
18 and 19	2	13	7	1		23	
20	2	14	8		1	25	
21	23	31	2			56	
Total	95	307	75	11	6	494	

cent of all larvae taken, and only 3 per cent were in the fourth and fifth instars. However, based on the comparative size of the frass pellets on the trays, there were many larvae in the later instars which were not taken. These may not have been killed by the insecticide as used. Only 12 first instar larvae of *Lambdina athasaria pellucidaria* were collected but the sampling error may have been high due to their small size and indifferent appearance when in a desiccated condition. It seems apparent that there was a large population of sawfly larvae in parts of this plantation and that considerable defoliation would have occurred had it not been sprayed.

Potatoes

The potato fields were selected first, for convenience to the designated service fields and, secondly, to obtain approximately ten-acre blocks with adequate checks. In spite of the care of selection and statements by the growers that both treated and check plots had received uniform treatment, in almost every case there were differences either in previous treatment or in treatment during the spray season which ruined any yield effects of helicopter treatments. The data are therefore confined to records of abundance of insects, as obtained by sweeping with a net, following treatment.

After treatments of July 3 and 4, counts were made July 6 and 9. The July 11 treatment was examined July 13. Following the July 12 applications, rain, etc., prevented counts until July 20. No counts were made following the final treatments in August. Various delays prevented application before the insects decreased in abundance naturally. The detailed results are given in Table 21 below.

In most cases the results against flea beetles were reasonably clear-cut. However, the treatments on the Liebman, Wetstone and Mulnite farms did not appear to control flea beetles. The same treatment on the same day worked well on the Bahler farm. These conflicting results may have been caused by the time of emergence of the flea beetles. On both plots at Bahler's, flea beetles were very abundant when the treatment was made. Adult beetles were affected immediately and on the following day the ground between the rows was "black with dead flea beetles". Apparently, few adults emerged between that date and the 20th, when the count was made. The population on the Liebman and Mulnite farms was very low on July 9 and apparently did not build up until *after* the treatment had been made. It is suggested, therefore, that the timing of the treatments in relation to flea beetle emergence was responsible for the apparent failure to control beetles on the Liebman, Wetstone and Mulnite farms.

Populations of flea beetles were extremely low on the Daigle and Steane farms all season. Both growers made June applications of dust to control this pest.

Counts on all farms, particularly the Daigle farm, showed that the residues of DDT were either not heavy or not persistent enough to

TABLE 21. POTATO INSECTS

Location	Treated	Examined	Leaf-hoppers	Aphids	Flea beetles	Plant bugs	Lady beetles	Diptera
Daigle Farm Cheshire, Conn.	July 3	July 6	16	70	1		4	11
	Check	July 6	54	99	7		9	10
	July 11	July 13	0	407	0		7	5
	July 3 and 11	July 13	0	64	0		2	5
	Check	July 13	48	628	0		6	8
	July 3 and 11	July 25	41	10	224		12	15
	Check	July 25	50	30	233		16	39
	July 11	July 25	31	21	291		10	32
	Check	July 25	83	25	488		11	29
Liebman Farm Ellington, Conn.	July 4	July 9	8	3	23	2	0	77
	Check	July 9	27	7	69	5	0	270
	July 12	July 20	6	28	2615	0	8	52
	Check	July 20	12	50	2263	0	8	37
Bahler Farm Ellington, Conn.	July 4	July 9	0	2	104	1	0	34
	Check	July 9	5	4	438	0	5	37
	DDT Ground Spray[1]		6	4	341	8	0	43
	July 12	July 20	8	42	847	0	6	37
	Check	July 20	2	45	2469	0	1	84
	DDT Ground Spray[1]		8	59	2305	0	9	38
	July 12	July 20	8	54	714	0	10	55
	Check	July 20	18	160	4577	0	11	59
Mulnite Farm East Windsor, Conn.	July 4	July 9	3	0	5	0	0	23
	Check	July 9	5	0	11	3	0	41
	July 12[2]	July 20	1	43	2055	0	6	65
Steane Farm Manchester, Conn.	July 4	July 9	6	12	56	2	0	48
	Check	July 9	6	24	97	3	2	21
Wetstone Farm Ellington, Conn.	July 12	July 20	10	244	2134	0	9	53
	Check	July 20	42	277	1751	0	10	46

[1] About 0.7 lb. DDT per acre
[2] Entire field treated.

kill the beetles as they invaded the fields after treatment. It must be noted, however, that Bahler's conventional spray with about .7 pound DDT per acre per application in the form of a powder was much less effective than the helicopter application in controlling flea beetles.

Leafhopper counts were relatively low all season as most farms used Bordeaux mixture which would keep the population down. However, on the Daigle farm, the helicopter treatments were made on

a plot sprayed with Dithane which does not control leafhoppers. The three treatments controlled leafhoppers satisfactorily and no serious hopperburn ever appeared.

No "outbreaks" of aphids occurred on treated farms. In every case treated plots had less aphids than untreated. On the Daigle farm there was an apparent control of 90 per cent following two treatments. Rains caused a rapid drop in the population soon after. This type of treatment apparently has at least some merit in aphid control, and the repeated applications for control of flea beetles might be expected to prevent aphid "outbreaks".

Plant bugs were not abundant in any fields, and treatment usually reduced their numbers.

Counts of coccinellid larvae and adults and braconids were included under "lady beetles" in the tables. There was no indication that the treatment reduced the population of these beneficial insects very seriously. The numbers of all flies were reduced in most cases. Although no effort was made to determine the effect of spraying potatoes on birds, one chipping sparrow seriously affected with symptoms closely resembling DDT poisoning, was found in the Daigle field July 13.

Apple Maggot

An orchard plot was sprayed twice for apple maggot control, but the results were not satisfactory.

Birch Leaf Mining Sawfly

Another failure to get results was on a five-acre plot of birches that were infested with *Fenusa pusillus* Lepeletier, a birch leaf mining sawfly. At the time of staking out the plots, large numbers of adults were present. Spraying took place several days later. An examination of the plot was made two days after spraying and no adults could be found either alive or dead on the cloth mats pegged to the ground. This was also true of check plots, so that no conclusions could be drawn on the effect of the DDT.

Japanese Beetle

On the morning of August 13, 1945, the helicopter sprayed a 10-acre wood lot in the town of Bloomfield for the control of Japanese beetles. Cloth mats were placed under the following five species of trees: sweet cherry, elm, gray birch, linden and sassafras. All of these are especially attractive to Japanese beetles and were, at the time of treatment, considerably damaged by beetle feeding. A heavy population of adult beetles was present the morning the DDT was applied. Beetles began to fall to the ground within a few minutes after the spraying started and were observed lying on their backs and kick-

ing, not only on the cloth mats but also on the ground in the vicinity. Many of the beetles were collected and placed in containers for observation. One hour after the spray was applied some of the Japanese beetles seemed to be recovering from the effect of DDT while others appeared to be dead.

At 12:30 P. M., or two hours following the spray application, beetles continued to fall to the ground. At this time some of the beetles that had been picked up and placed in containers a few minutes after the spray was applied were still kicking, others were quite lively and still others appeared to be dead.

At 5:00 P. M. beetles fell to the ground as they came in contact with sprayed foliage. At this time it was estimated, from counts made throughout the day of beetles that had fallen to the ground and either recovered or died, that only about 10 per cent mortality resulted from DDT during the first few hours after application.

The following day, August 14, a number of Japanese beetles were seen on the ground under the sprayed trees. Some of these were dead, while others were kicking. A few of the dead beetles may have fallen the previous day. However, there were fewer beetles on the ground on the 14th than on the 13th. Certain sprayed trees showed no beetles whatsoever, whereas beetles were seen on the foliage of other trees. A five-leaf ivy in one section of the wood lot was covered with beetles and in another section no beetles were seen on the same species of vine. At the time of the spray application the wind was blowing, consequently, certain parts of the wood lot received more spray than other sections and by the same token some areas received none at all. This will perhaps help to explain in part, at least, the variations in results.

On August 17, a few dead beetles were found under the trees. However, no beetles could be seen on the following trees: cherry, birch and linden. A sassafras that had been definitely sprayed with the DDT showed few beetles feeding. On August 21, no beetles could be found on the cloth mats or on the ground. There were many more beetles feeding in the trees than on the 17th. Apparently, beetles had come back to the wood lot in large numbers and seemed to be suffering no ill effect from the DDT, at least no beetles could be seen falling to the ground. On August 28, large numbers of beetles were seen feeding on the sprayed trees, especially so on five-leaf ivy, sassafras and linden.

Orange-striped Oak Worm (*Anisota senatoria* S. and A.)

On August 28 three plots of oaks of five acres each were sprayed to control the orange-striped oak worm. At this time the larvae were in the third to last instar, in fact a few had pupated. Control was not considered good. If the spraying could have been done earlier while larvae were smaller and before the trees were severely defoliated, the results might have been better.

Mosquitoes

A series of concerts was scheduled to be held in Yale Bowl during July and August. We anticipated that mosquitoes would be a nuisance to the audience so it was decided to spray the Bowl and surrounding land the day before the first concert to determine the practicability of this type of mosquito control.

The evening before spraying, three of our staff visited the Bowl and collected many mosquitoes in a short period of time. The evening of the concert the Bowl appeared free of mosquitoes. The audience was watched carefully, but no evidences of mosquitoes were seen. We talked to people in the audience and all agreed that they were not annoyed by these pests. It was also noted that there was a scarcity of insects around the lights over the musicians. People who lived in the neighborhood remarked about freedom from mosquitoes for nearly two weeks. Only one mosquito was seen the night of the concert and that was in a refreshment stand. It could have been inside the building when the spraying took place. About five days after treatment, mosquitoes began to appear in the Bowl.

For later concerts a ground sprayer was used until the last event, when the helicopter sprayed the entire Bowl again as well as some of the surrounding area. The control was excellent, as before.

Discussion

The helicopter as an apparatus for applying insecticides has certain advantages when compared to the winged type of plane. It does not require a large landing field. In actual practice this machine alighted in and took off from such places as the middle of an orchard, a clover field, the center of our farm at Mount Carmel, etc. It is very maneuverable and operates well on relatively small areas. The insecticide was distributed satisfactorily as far as the machine is concerned. The failure to kill insects in some cases cannot be attributed to an unsatisfactory deposit of the spray.

The disadvantages are quite obvious, but some of them can be overcome. The machine we used had a load capacity of 30 gallons and flew at a slow speed. It is fully as difficult to fly as a winged plane and the pilot has to concentrate on his job every minute he is in the air. Moreover, the cost of the helicopter is rather high.

MIST BLOWERS FOR APPLYING CONCENTRATED SPRAY

S. F. Potts[1] and R. B. Friend

The conventional method of spraying trees to control insect pests involves the application of large volumes of dilute insecticidal mixtures with powerful high-pressure sprayers, which is expensive in labor, material, equipment, and time. From 10 to 40 gallons of standard lead arsenate spray (five to 20 ounces of insecticide) are required

[1] Entomologist, Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture.

to cover the foliage of a well-developed street tree. This means eight to 30 trees per 300-gallon tank. Moreover, the application of large quantities of spray, even to the extent that excessive run-off occurs, does not by any means assure thorough and uniform coverage.

The development of a mist blower which will apply thoroughly a small quantity of a concentrated insecticide is the logical result of an effort to overcome relatively cumbersome methods. Such an apparatus should atomize the spray adequately; give good and rapid coverage with a small volume; project the mist up to 100 feet vertically and 200 to 300 feet horizontally (in quiet air); deliver solutions, emulsions or suspensions, and be light in weight as compared with standard sprayers.[1]

The idea of applying relatively small quantities of insecticides in the form of finely divided mist, using a blower, is not new. In 1928 Potts used an orchard duster to apply oil-coated dust and concentrated sprays atomized into the discharge pipe. This work was preliminary in nature, and inadequate air volume and velocity restricted the projection of either dust or spray to a height of 35 to 40 feet.

In 1934 French (1) published a description of blower equipment for applying atomized oil sprays. Among other things, he was interested in droplet size, particularly since he was applying a contact insecticide. The oil was partly atomized by passing it through a disk nozzle under pressure and further atomized by an air blast of large volume and high velocity. French determined the relations between (1) gallons per minute, quantity per acre, and speed of travel of his machine; (2) gallons per minute, pressure per square inch, and size of nozzle; (3) oil pressure and droplet size, and (4) air velocity and droplet size.

In 1942 French (2) described two types of air-atomizing ground sprayers for applying concentrated sprays to vineyards and orchards, a compressed-air sprayer and a mist blower. He gave specifications for air pressure, volume and velocity, and emphasized the importance of droplet size. One of the machines described by French is the type used by us after being modified to project the mist a greater distance and equipped with different nozzles.

The apparatus described below is still in the developmental stage and is, of course, subject to further modification and to standardization, particularly in respect to the relation of deposit to control. It was developed primarily for treating shade trees and young forest plantations, or limited areas of more nearly mature forest stands, but it may well be found useful for other purposes. Rather than build a blower of original design, we borrowed a "vapo-duster" and an orchard duster and installed the pressure nozzles on the modified air blast orifice.[1]

[1] Since interest in this type of blower has been stimulated by the work of Potts, at least two designs have been placed on the market.

The "vapo-duster" had a 25-horsepower motor driving a fan which delivered about 8,730 cubic feet of air[2] per minute at an outlet velocity of about 124 miles per hour.[3] (Figures 6, 7 and 8.) It

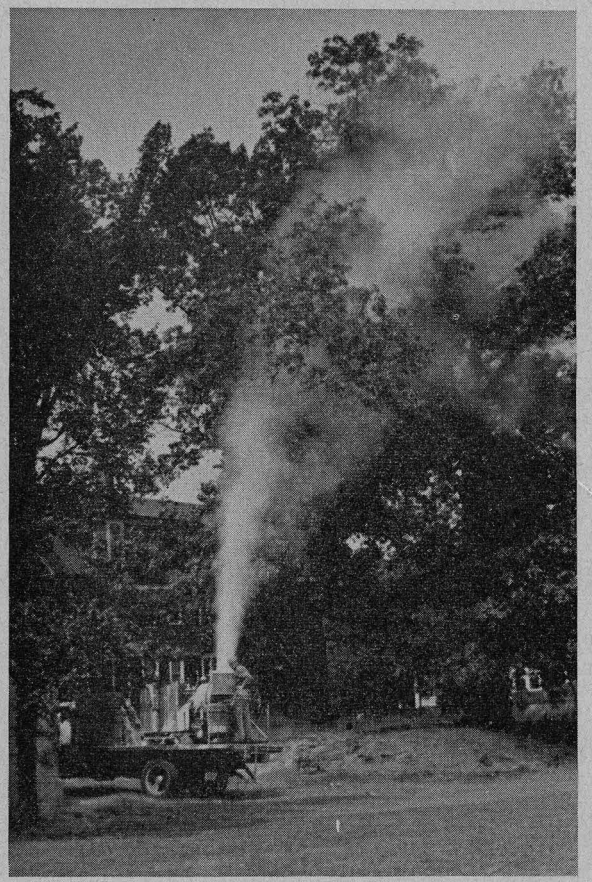


Figure 6. Twenty-five-horsepower blower-atomizer treating an 80-foot red oak, using 12-inch-diameter discharge tube. A small amount of dust was added to facilitate photographing.

was modified by removing the fishtail outlet and replacing it with a short cylindrical discharge pipe 12 inches in diameter. Since only

[1] The authors are indebted to H. G. Ingerson and W. J. Norton of the John Bean Manufacturing Co., to T. C. Matteson of Wethersfield, Conn., and to C. O. Eddy of the Niagara Sprayer and Chemical Co. for the loan of equipment and for valued suggestions and advice, to J. H. G. Fraser, who made several special nozzles, and to R. Spencer of the Connecticut Agricultural Experiment Station, who rendered valuable assistance in the tests and made some of the equipment.

[2] Cubic feet per minute $= 4005 \sqrt{Pt} \times \frac{\pi r^2 \times 12}{1728}$

[3] Velocity $= \frac{4005 \sqrt{Pt} \times 60}{5280}$ m. p. h.

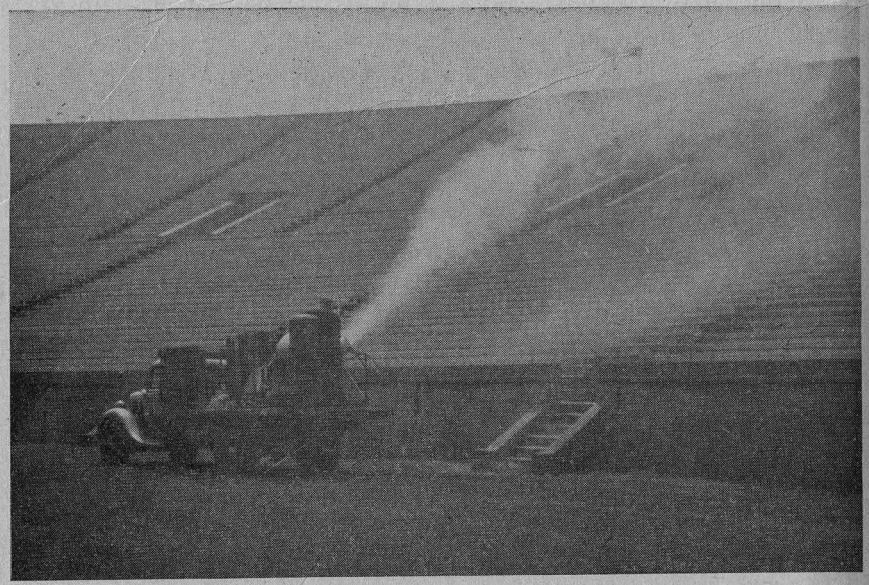


Figure 7. Twenty-five-horsepower blower-atomizer treating interior of Yale Bowl for control of mosquitoes.

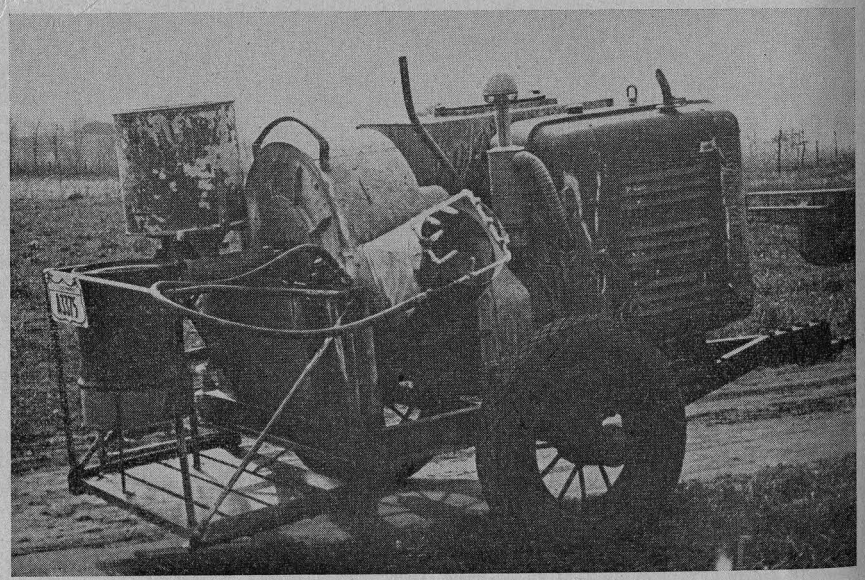


Figure 8. Twenty-five-horsepower blower-atomizer on trailer showing (1) large and (2) small tank, (3) dust hopper, (4) hand-operated spray shut-off lever, and (5) ring of 8 oil-burner nozzles mounted in discharge outlet at a 45° angle to air blast.

small quantities of insecticide were to be used, a 15-gallon tank was installed. The orchard duster had a 12-horsepower motor driving a fan which delivered 1,200 cubic feet of air per minute at a velocity of 150-175 miles per hour. (Figure 9.) Its discharge tube was modified by placing over the end a sleeve carrying the nozzles and necessary tubing. A five-gallon and a 14-gallon tank were installed.

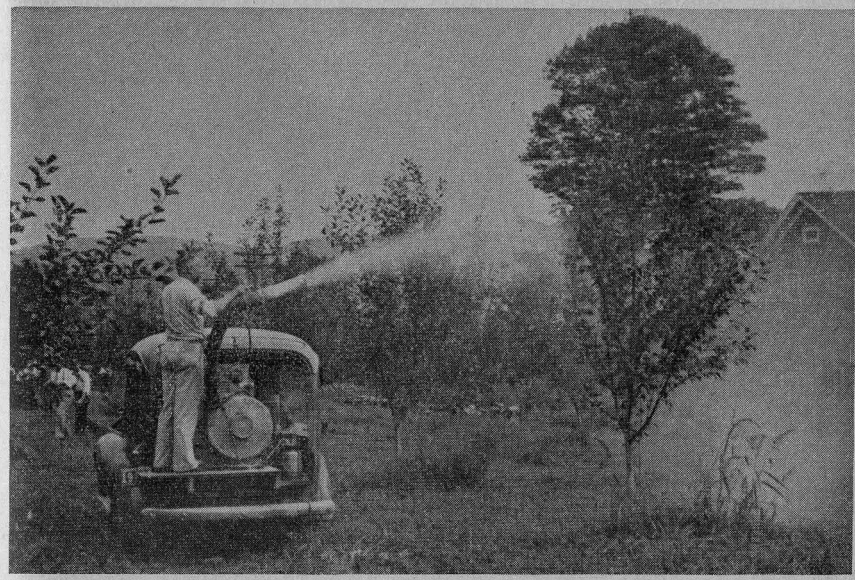


Figure 9. Twelve-horsepower high-velocity blower-atomizer treating orchards, using flexible 4-inch-diameter discharge tube.

A gear pump capable of delivering up to five gallons per minute at 80 pounds' pressure, together with a ¾-horsepower engine to run it, was installed in each of these machines. These gear pumps are satisfactory when solutions or emulsions are used, but will not stand the abrasiveness of many suspensions. Plunger pumps are probably best for all mixtures and pressures. One of these, delivering up to four gallons per minute at 250 pounds' pressure, was installed on the "vapoduster".

The proper nozzle arrangement is a complicated problem, for not only are the output and droplet size affected by the pressure and nozzle design, but the angle at which the nozzle directs the insecticide into the air stream of the blower is also important. We have used two kinds of nozzles, a direct-pressure type which delivers a fairly fine spray into the air stream, and a so-called "air-velocity" nozzle which delivers the insecticide at low pressure into the air stream, all the atomization being caused by the air stream.

Two designs of direct-pressure nozzles have been found satisfactory. In one design a number of conventional oil-burner nozzles, having apertures of 0.018, 0.02, and 0.027 inch for delivering 1.8, 2.7, and

5.0 gallons per hour per nozzle, respectively, at 80 pounds' pressure, were arranged around the blower orifice and usually set to feed a spray into the blower air stream at an angle of 45 degrees (Figure 10). In a second design a single nozzle, with an orifice 0.086 inch in diameter was set inside the air-stream orifice and directed to feed a spray directly against the air stream at 150 to 250 pounds' pressure and about one-gallon per minute (Figure 11). The spray from direct-pressure nozzles is, of course, broken into finer droplets by the air stream of the blower.

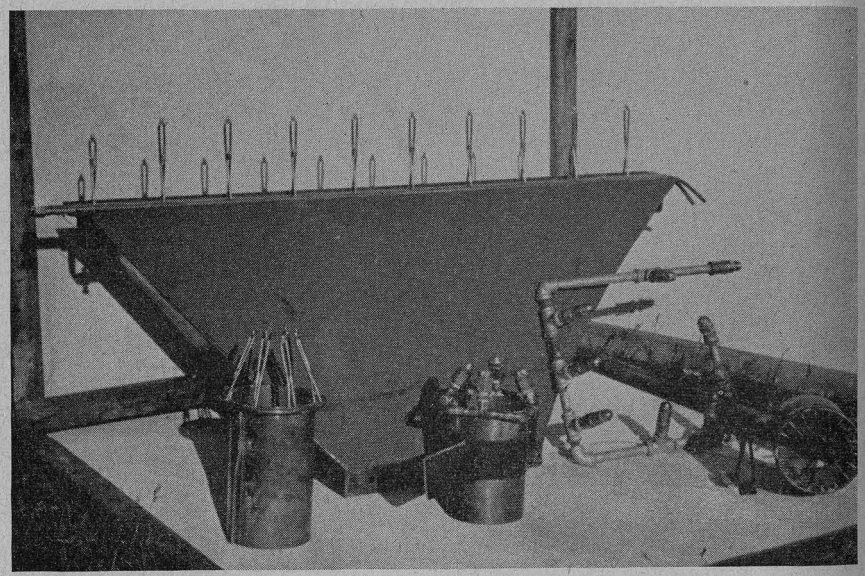


Figure 10. Nozzle manifolds. Top: Ten No. 152 DeVilbiss nasal-atomizer nozzles mounted on a fishtail outlet, 38" x 3-1/2". Bottom, left to right: (1) 8 DeVilbiss nozzles on 4-inch diameter manifold, (2) direct-pressure atomizing nozzles with interchangeable tips of different sized orifices set at 45° angle to air blast, (3) direct-pressure atomizing nozzles for 12-inch-diameter discharge outlet, and (4) air-velocity nozzle with 18 1/16-inch-diameter capillary tubes for applying atomized spray or spray-dust. The DeVilbiss nozzles gave insufficient volume of spray and were discarded.

The "air-velocity" nozzles (Figure 11) consisted of groups of capillary copper tubes of 1/16-inch inside diameter, arranged so that they projected into the air stream at right angles to it. The insecticide was delivered at five to eight pounds' pressure. The atomization was effected entirely by the shearing action of the air stream. One of the "air-velocity" nozzles could be rotated through an arc of 180 degrees; so the position of the tubes with respect to the direction of the air stream could be changed. In another type the speed of the air stream across the openings of the tubes could be changed by moving a deflecting cone forward or backward.

Several insecticidal mixtures have been applied with this apparatus. That most frequently used was a solution of one pound of DDT

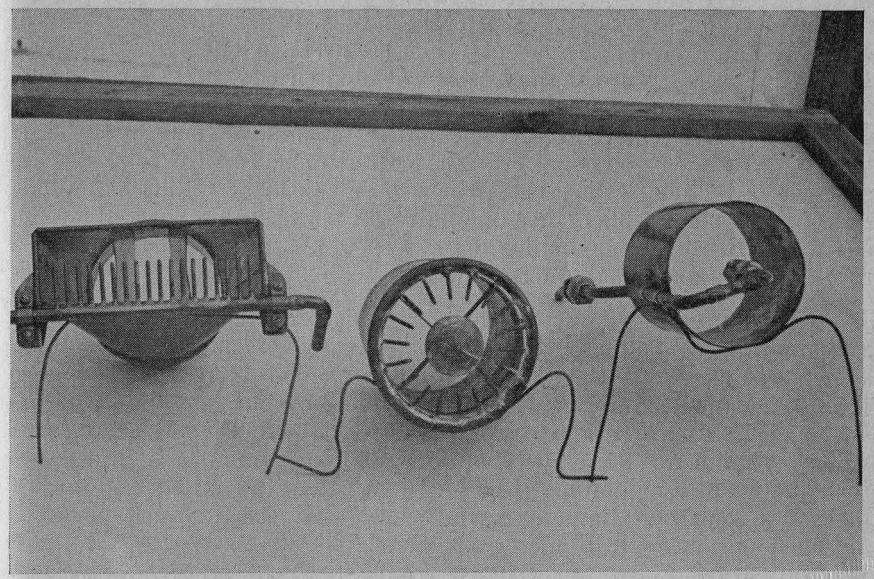


Figure 11. Left to right: (1) An air-velocity nozzle with mechanism for regulating the size of droplets by changing the position of the capillary tubes with respect to direction of air blast; (2) air-velocity nozzle with adjustable cone in center for increasing the speed of air flowing across the nozzle orifices; (3) a special type of conventional whorl nozzle reversed against the air blast (using 150 to 250 pounds direct pressure), and constructed for attaching different-sized tips.

in one quart of xylene plus three quarts of kerosene or horticultural base oil, giving approximately a 12 per cent concentration of the DDT. For some applications, this solution was diluted with an equal volume of kerosene to make a 6 per cent DDT concentration. The DDT was also dissolved in kerosene or fuel oil at the rate of 0.5 pound per gallon. Emulsions containing about 5 and 10 per cent of DDT were tried, but to obtain good results when the mist is blown long distances some non-volatile liquid, as a mineral oil, should be included in the formula. Other insecticides applied, using either water or oil carriers, included pyrethrum extract, rotenone (derris or cubé), nicotine sulfate, nicotine alkaloid, benzene hexachloride, and lead arsenate. Some of the mixtures mentioned, particularly the DDT solutions, would cause foliage burn if applied in any great quantity, but small amounts, which cause no visible injury to foliage but are lethal to insects, can be successfully applied with the blower. This is made possible mainly by the small size of the droplets produced.

Particle size,[1] important in the application of any spray, if for no other reason than its significance in respect to deposit, is affected by characteristics of both equipment and insecticide. The size of drops coming from the nozzle is reduced by the air blast in the air-

[1] Volume of drop = 4.2 R^3 (R = radius of drop).

discharge tube. An increase in the air velocity increases atomization. The air blast apparently has its greatest effect on drop size when the spray from the nozzle is projected in the direction opposite to the air blast. The drop size is also affected by the pressure at the spray nozzle, greater pressure resulting in larger size with "air-velocity" nozzles and smaller size with direct-pressure nozzles. In case the latter nozzles are used, the drop size can be reduced one-half by reducing the nozzle orifice one-half and maintaining the same pressure, but with the same orifice the pressure must be about quadrupled to reduce the droplet diameter one-half.

Increasing the diameter of the air-blast orifice increases atomization. The continued breaking up of drops in the air stream for some distance from the outlet is due to the maintenance of a high velocity, made possible by the large volume of moving air. For example, the same average drop diameter (37 micra) was produced when kerosene was sprayed through a whorl disk nozzle with a 0.086-inch orifice at 200 pounds' pressure against a 150 mile-per-hour air blast in a four-inch diameter air outlet, as against a 120 mile-per-hour air blast in a 12-inch diameter outlet.

The composition of the insecticide obviously affects the size of the droplets. A light oil sprayed at 250 pounds' pressure through a 0.086-inch nozzle orifice against an air blast of 120 miles per hour produced an average particle size of 36 micra. With the same apparatus and pressure, the average particle size of lead arsenate and cryolite concentrates was about 50 micra. The addition of a wetting agent, such as Santomerse D (essentially decylbenzene sodium sulfonate) at 0.02 pound per pound of insecticide reduced the diameter of drops to 42 micra in the lead arsenate and cryolite mixtures. A suspending agent (Daxad No. 14, a salt of polymerized arylalkylsulfonic acids) slightly increased the drop diameter. An increase in the viscosity of the oil from 50 to 200 Saybolt seconds nearly doubled the drop diameter.

The mere fact that certain size drops leave the air outlet does not imply that the same size drops are deposited on the surface to be sprayed. When the insecticide leaves the air-blast orifice, the drops vary in size and in the proportion of drops of different sizes. The larger drops continue to shatter while traveling through the air some distance from the orifice. As this distance increases, the spray stream expands, air dilution increases, and the proportion of drops of different sizes changes. The larger drops, of course, tend to settle out of the air stream and deposit first. Therefore, foliage near the machine may receive a heavier deposit than that farther away unless the air outlet can be modified so as to divert and distribute a small part of the spray near the blower. For example, an oil having a Saybolt viscosity of 40 seconds was projected by an air blast of 120 miles per hour parallel to the ground. Samples of the spray were taken on exposed glass slides three feet above the ground in the center of the stream. At 25, 50, and 100 feet from the blower, the mass average diameters of the drops that deposited on the slides were 42, 38, and 36 micra, respectively, a reduction in volume per drop of 38 per cent in traveling a distance of 100 feet. Samples taken in the settling box 50 feet from the blower outlet showed that 9 per cent of the spray volume and 31 per cent of the number of drops were too small to deposit on a perpendicular glass slide. At distances of 25, 50, and 100 feet, the numbers of drops deposited per square millimeter per second were 300, 44, and 16, respectively. At drop sizes of 20, 30, 40, 50, 60, 70, and 100 micra average diameter, it would be necessary to obtain, respectively, 222, 65, 28, 14, 8.2, 5.2, and 1.78 drops per square millimeter to equal one gallon (3,785,000,000,000,000 cubic micra) per acre of surface.

If air-borne drops are to be carried to great heights and drift for long distances, at the same time providing good coverage, the drops must be very small. However, they must be sufficiently large to deposit on foliage and insects. Under conditions normally met out of doors, most drops less than 20 micra in diameter do not deposit on the surface of leaves. A mass average diameter of 35 to 60 micra appears to give the best deposit for most conditions. Some conception of the mass of drops when distributing a certain volume of spray material can be obtained when it is realized that cutting the drop diameter in half reduces its volume seven-eighths and hence increases the number of drops eight times, a ratio of the cube of the diameter.

To compare drop sizes under different conditions, certain standardized techniques must be employed. To determine the size of drops deposited, coated glass slides were used. The coating was cellulose nitrate, 2 per cent ferric stearate in benzene, or DRI-FILM.[1] All of these materials reduced the spreading of the drops on the slide. The drop diameters were measured through a microscope using an ocular micrometer grid, and the number per square millimeter was recorded. With these data, it is possible to compute the volume of spray deposited per unit of area.

The glass slides were placed in certain types of apparatus to make certain that all sizes of drops could be measured. To determine the deposit on a vertical surface, an apparatus based on a focal-plane shutter plan was employed (Figures 12 and 13). A pair of rollers, or cylinders, was set for running a strip of clean photographic film at a uniform speed in front of the glass slide. Slots of definite width in the strip permitted exposure of the slide for a definite length of time. Thus, with the strip moving 11 centimeters per second, a slot one centimeter wide exposed the slide 0.09 second; and a slot five centimeters wide exposed it 0.45 second.

Extremely small drops do not deposit well on vertical surfaces under field conditions. Therefore, with the apparatus described above, by no means all of the spray material delivered was measured. To determine the size and number of minute drops which would not so deposit, as well as the proportion of the spray deposit they represent,

[1] Product of General Electric Co.

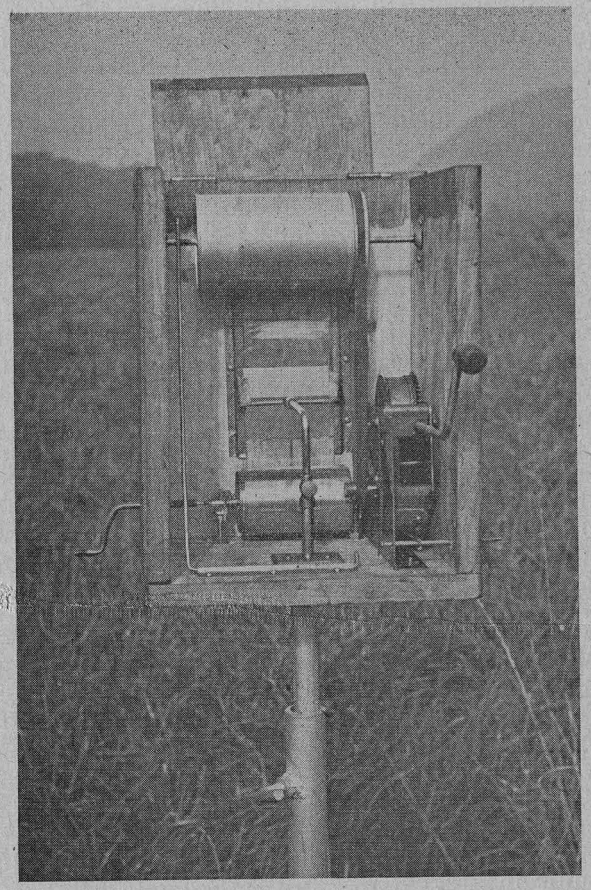


Figure 12. Interior view from back showing apparatus for obtaining particle-size samples by timed exposure of prepared microscope slide exposed at the front center of the box. The two rollers at the top and bottom of container are turned by a phonograph spring located in the lower right corner of the box.

a wooden box with a hinged door open at each end was set horizontally in the spray stream (Figure 14). The doors of the box were closed simultaneously and the box was rotated to a vertical position. The enclosed mist then settled down on the inner side of the bottom door, where an oleophobic slide (1 x 3 inches) had been fixed. The settling period was 13 minutes. Measurements of samples so collected showed that, when the median mass diameter of the drops fell below 30 micra, much of the spray was not deposited on vertical surfaces. With an average drop diameter of 13, 16, and 10 micra, a loss of 22, 65, and 94 per cent of the spray volume occurred as compared to the deposit on a vertical slide in the apparatus described in the preceding paragraph.

Figure 13. Front view of apparatus shown in Figure 12 in position for taking a particle sample.

Other factors, such as physical nature of the spray material, relative proportion of the ingredients, and meterological conditions, also affect the drop size. Optimum size of drops depends on many things —the insect to be controlled, the dosage and gallonage needed, the rate of drying the mixture, the drift and width of swath desired, etc.

Operation of Equipment

The height to which the blower will deliver the spray mist is important. The orchard duster drove the spray to the tops of 50-foot trees provided the wind did not exceed four miles per hour. This was an advantage in certain types of orchards where the machine was close to the trees. The "vapo-duster" could drive the spray to a height of 100 feet in quiet air, or 75 feet against a five-mile-per-hour wind. It

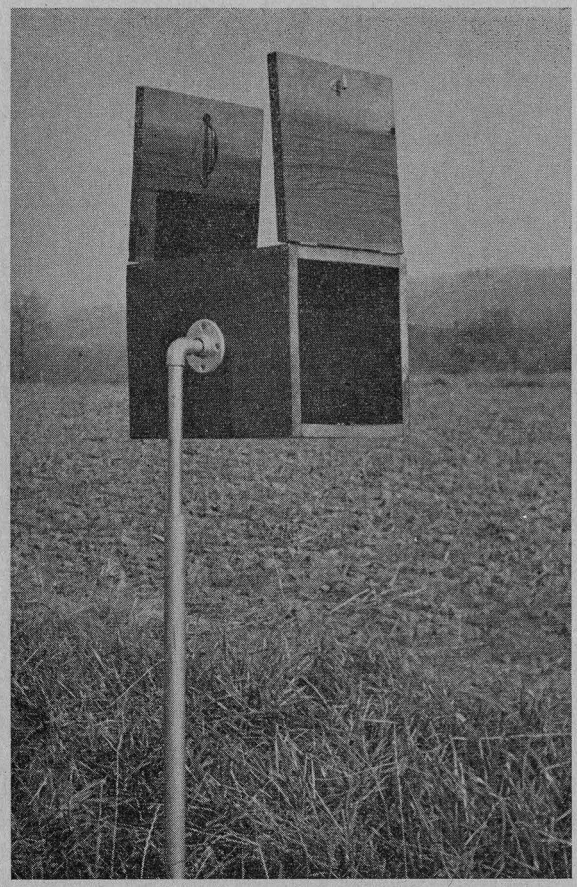


Figure 14. View of particle settling box when in position to trap a particle sample. Slide is placed in a holder in the back door.

could drive the spray horizontally for a distance of several hundred feet, depending on wind conditions. The movement of either machine has the same effect as moving air currents; that is, greater distance is attained when the machine moves slowly than when rapidly. The orchard duster was equipped with a flexible outlet pipe which permitted directing the spray in any direction, forward or backward, as well as up or down. The outlet on the "vapo-duster" could be rotated in one plane through an arc of 180 degrees to cover foliage from the ground up on either side. It could not project the spray backward or forward.

Results Against Insects

Dosages of DDT as low as 25 micrograms per square inch were completely effective against the gypsy moth [*Porthetris dispar* (L.)]

throughout the larval period. Thirty-two plots were treated, 12 of which were roadside or woodland plots, comprising a total area of 50 acres. Along roadsides, two to five ounces of DDT were applied to 100 linear feet. The concentration was one pound of DDT in one quart of xylene and three quarts of kerosene—a 12 per cent DDT mixture. The dose of two to five ounces gave good control for at least 200 feet from the machine in the absence of a contrary wind. Average figures for all plots gave an average DDT dose of 0.43 pound per acre, that is, an average volume of about 0.5 gallon. This gave nearly complete control in all tests. On the larger trees, for instance, oaks 85 feet high, a pint of solution (two ounces of DDT) per tree was sufficient to control the gypsy moth, spiny elm caterpillar [*Malacosoma americana* (F.)], forest tent caterpillar (*M. disstria* Hbn.), orange-striped oak worm (*Anisota senatoria* A. and S.) green-striped maple worm [*Anisota rubicunda* (F.)], fall webworm [*Hyphantria cunea* (Drury)], and the Japanese beetle (*Popillia japonica* Newm.) The tent caterpillar was slightly more resistant than the gypsy moth, but the fall webworm and certain May beetle (*Phyllophaga* spp.) adults were very susceptible. For Japanese beetle control, it may be necessary to spray twice during the season.

Mosquito control has been excellent in the tests made. The Yale Bowl and the surrounding area, comprising altogether about 25 acres, were treated twice to keep out mosquitoes during evening concerts. The dosage was one pound of DDT in one gallon of solution per acre. After treatment, the Bowl remained free of mosquitoes for at least five days. A 12-acre suburban block treated with the same dose remained free of mosquitoes for 10 days. We received no complaints from residents of the block regarding residues on automobiles, buildings, etc.

In cooperation with the Division of Fruit Insect Investigations of the Bureau of Entomology and Plant Quarantine, 23 plots were treated for the control of the pear psylla, the insecticide in this case being nicotine alkaloid (99 per cent pure) at the rate of 16 ounces per gallon of kerosene. Applied at four to eight ounces per pear tree, this mixture gave a control of adults of 90 to 96 per cent.

Economy of Operation

In treating the average New England hardwood forest, which contains four to six acres of foliage per ground acre, 20 to 30 pounds of lead arsenate are usually applied per acre with solid-stream, high-pressure sprayers. At three to five pounds per 100 gallons, this means 400 to 1,000 gallons per acre, 35 to 60 per cent of which misses the foliage, runs off, or otherwise ends up on the ground. The cost per acre for equipment, labor, and insecticide is about 20 dollars, and 10 acres can be treated per day with one sprayer and a crew of 10 men.

When suitable adhesives and wetting and dispersing agents are used, five pounds of lead arsenate can be suspended in one gallon of water and applied with a blower so that only four to six gallons of insecticide per acre are required. If a DDT concentrate is used, excellent control of the gypsy moth may be obtained with 0.5 pound of DDT in one gallon of kerosene per acre, costing about 40 cents per acre for materials. From 20 to 48 acres may be covered per hour at a total cost of about 75 cents per acre. This all assumes that roads are available so the machine can reach the woods.

In spraying shade trees for cankerworm and elm leaf beetle control, large elms usually require 10 to 20 gallons, or more in some cases, of diluted spray. This means that 20 to 40 trees could be covered per 400-gallon tank. With a suitable blower, it is possible to deposit the same quantity of lead arsenate on the tree, and more quickly, with one quart of concentrate. When the delivery rate is 30 gallons of concentrate per hour, trees receiving 2, 1, ½, ¼, or ⅛ pint of spray per tree, require 30, 15, 7.5, 4, and 2 seconds of spraying time, respectively, per tree. A 100-gallon tank could cover 800 trees at one pint per tree, and the same amount of material is enough for 100 acres at one gallon per acre.

Literature Cited

(1) French, O. C. 1934. Machinery for Applying Atomized Oil Sprays. Agr. Eng. 15(9) :324-326, 329.

(2) French, O. C. 1942. Spraying Equipment for Pest Control. Calif. Agr. Expt. Sta. Bul. 666, 42 pp.

ADULT JAPANESE BEETLE SPREAD AND INTENSITY OF INFESTATION IN CONNECTICUT IN 1945

John C. Schread

Japanese beetle infestation in Connecticut during the summer of 1945 showed varying degrees of intensity, attributed in part to the severe drought in the previous summer of 1944. The dry season in question was more protracted and severe in the southwestern part of the State, in Fairfield and New Haven counties, than elsewhere in Connecticut. However, most of the State felt the scarcity of rain for at least part of the season.

The effect of the drought on the Japanese beetle was two-fold. First of all, turf areas became dry and brown and consequently unattractive to adults for oviposition. Secondly, if and when Japanese beetle eggs were deposited in such a situation or in ground which later became parched, they either dried out and failed to hatch or the first instar larvae died. It became evident that in the shore towns in Fairfield County many grubs that succeeded in reaching the second instar, owing to early deposition of eggs, died later in the season. It would appear that in certain other sections of the State, for example, upper New Haven County, Litchfield County and parts of Hartford County, there was sufficient rainfall to keep the ground reasonably moist and thus suitable for Japanese beetle grub development.

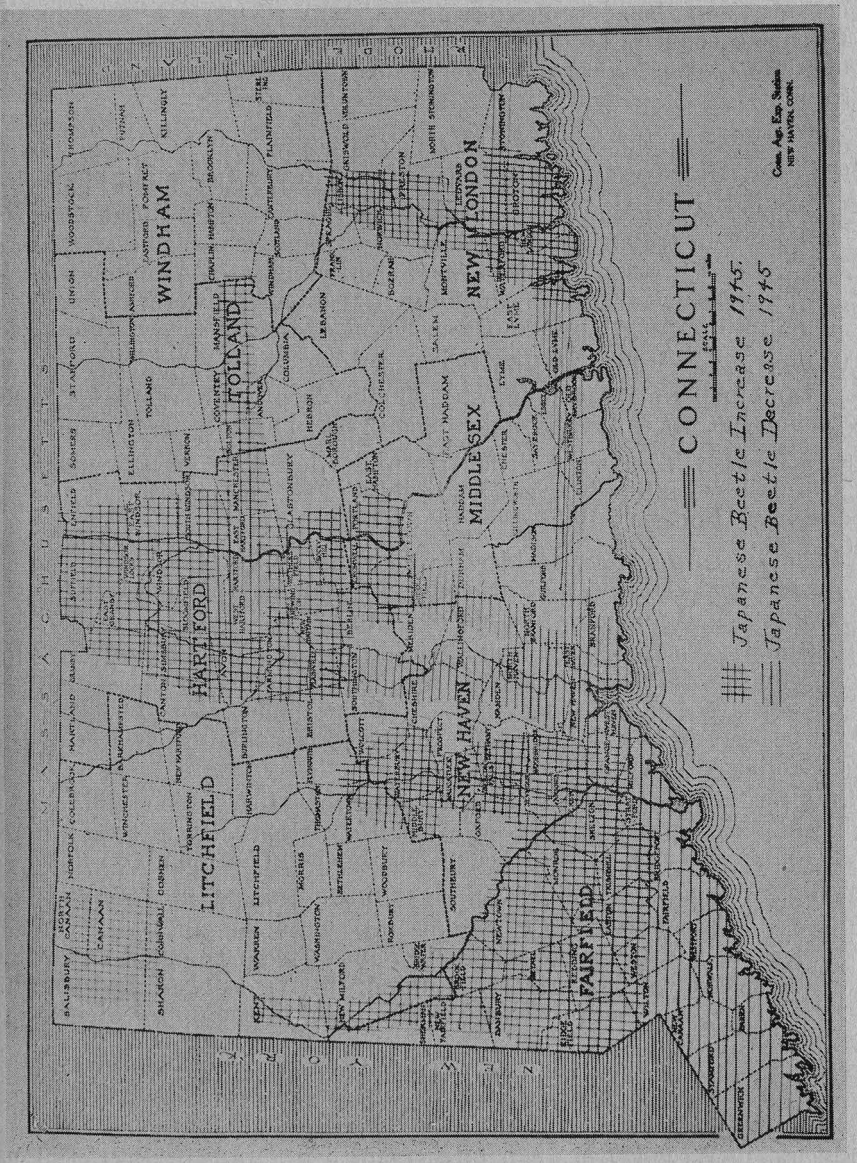


Figure 15. General distribution of Japanese Beetle in Connecticut during 1945.

The accompanying map of Connecticut (Figure 15) gives a reasonable picture of the Japanese beetle infestation in much of the State in 1945. Evidence at hand indicates that the beetle infestation is practically negligible in the towns in the eastern part of the State from North Stonington along the Rhode Island State line to Thompson on the Massachusetts State line. Beetles were not found in most of Windham and Tolland counties. In some of the towns in these counties, none has ever been seen. In many towns in Middlesex and Litchfield counties beetles were not abundant, and in most cases evidence of feeding on certain favored host plants was absent or difficult to find.

In general, the Japanese beetle situation in 1945 in the sections of the State which were scouted is indicated in the following notes.

Danbury: West to New York State line—feeding light to very heavy in trees. Damage more severe and more general than in 1944. In fruit orchards west of the city of Danbury, early peaches and Elbertas ripening in September were attacked by adult beetles. Upward of 5 per cent of the foliage was damaged.

West Haven, Orange, Milford, Devon: From West Haven, west to and including Devon, infestation much below that of 1944. Feeding in trees extremely light in contrast to heavier feeding in 1944.

Stratford, Bridgeport, Fairfield: Infestation was far below that of 1944. Feeding in trees negligible. Feeding on other types of vegetation very light.

Nichols: Infestation considerably less than in 1944. Light feeding in trees. Heavy, spotty feeding in grapes. Damage receding in north and northeast section of town.

Southport, Westport, Norwalk, Darien, Noroton: Southport west, including all towns to Stamford town line. Beetle abundance greatly reduced from 1944. Feeding much less extensive, especially in trees—where an average of less than 5 per cent of the foliage was injured.

Stamford, Riverside, Cos Cob, Greenwich: Infestation and extent of feeding greatly reduced over 1944. Especially in trees where, on an average, only a trace of feeding could be found.

Hamden, Mount Carmel, Cheshire, Milldale, Plantsville, Southington, Plainville, Farmington, Avon, Simsbury, Granby: Infestation much less than in 1944. It gradually reduces from Hamden north but becomes quite heavy in Farmington, only to decrease again as the Granby line is approached. Farmington is the center of infestation in this area.

New Haven, Derby, Shelton, Ansonia area: New Haven, west through West Haven and Orange had a greatly reduced population in comparison with 1944. Beetle population considerably less in West Haven than farther north in Orange. Beetle population in Orange slightly greater than at the Derby-Orange town line. Population in East Derby and the eastern side of Ansonia considerably less than in the western and northern section of Derby. Population in northwest and western part of Shelton very heavy. South Shelton not quite as heavy as in the other sections of the town. Extensive feeding in trees in Shelton with the exception of the southern part of the town.

However, the beetle population in Shelton, Derby and Ansonia, for the most part, is considerably less than it was the previous year. Unquestionably, Japanese beetle infestation in the lower Naugatuck Valley has progressed more rapidly during the last three years than it did during the previous six to eight years.

The area south of Shelton Center, to and including the northeastern section of Stratford adjacent to the Housatonic River, shows the Japanese beetle infestation dropping down much below that of Shelton proper until the Stratford-Shelton town line is approached, at which point there is every indication of a measurable rise of beetle population revealed in the type of vegetation attacked and the degree of injury. Japanese beetle infestation declining rather abruptly from northwest Shelton to a point about half way between Shelton Center and Huntington Center where it reaches the zero point. From there to Huntington Center, a slight rise in beetle population is perceptible until in Huntington Center beetles were sufficiently abundant to cause light damage to trees.

Danbury, New Milford, Kent area: Increased beetle abundance over 1944 in the entire area, feeding gradually disappearing on approach to Cornwall-Kent town line. No beetles found or reported in Cornwall—no perceptible feeding on any type of vegetation.

New Haven to Hartford area—via Middletown and Rocky Hill: Beetle infestation apparently not as heavy as in 1944. The heaviest damage occurs in the section including Middletown and Cromwell. This is noticeable not only on herbaceous vegetation, but also on trees.

Hartford north to Massachusetts State line: Infestation decreases gradually as State line is approached. Damage is especially noticeable in the vicinity of East Windsor and Enfield.

New Haven north to Hartford and east to Danielson: Extensive feeding on shrub and herbaceous foliage noticed in Berlin and Manchester areas. Beetle population fairly constant, damage to foliage about 5 per cent, up to Willimantic where it rapidly decreased with no beetle damage evident from Hampton to Danielson. Feeding light up to North Haven from New Haven. Then decreased from North Haven to Meriden where it sharply increased to 5 per cent and held there until the Berlin area.

New Haven to New London area: Amount of injury to foliage by feeding remained from 3 to 5 per cent until Guilford where it was difficult to find evidence of infestation. The amount of feeding, though scarce, fluctuated but little, disappearing entirely

around Madison. Evidence began to show near Clinton only to disappear near Saybrook, being hard to find but gradually increasing with a sharp rise at Waterford where feeding and infestation were extensive. Infestation decreased slightly as the Rhode Island State line was approached. The infestation and feeding showed a decided drop from that of 1944.

Groton-Thompson area: Beetle infestation and feeding moderate from Groton to Norwich. Signs of feeding gradually diminished between Norwich and Jewett City, at which point no trace could be found. This condition existed from Jewett City to the State line with the exception of Putnam where feeding and infestation were noticed.

MILKY DISEASE EXPERIMENTS OF FOUR TO SEVEN YEARS' STANDING

JOHN C. SCHREAD

Owing to the severe drought of 1944, no grubs could be found in many of a large number of "milky" disease plots established from four to seven years ago. This was due to drying out of the soil causing a desiccation of the Japanese beetle eggs laid therein or the starvation and drying up of the first instar grubs hatching from unharmed eggs. In certain cases the soil became unattractive to adult Japanese beetles because of the parched condition of the earth, and no eggs were deposited.

It may be seen in Table 22 that a high incidence of disease continues to occur in Hartford County in comparison with Fairfield County. This has been true from year to year since the experiments were first laid out. It is regrettable that a quantity of data could not be had for the three principal counties of the State. However, it appears that the trend in Japanese beetle grub control in experimental plots has been progressive for the past few years.

In 1940[1] 3.1 per cent disease was recorded for all experimental plots in the State; in 1942, 10.7 per cent and, in 1943, an average of 19.6 per cent, including checks, was recorded for Connecticut. The 1943 average for the State showed a rise to 24.08 per cent disease in the treated plots. The following year, 1944, the disease reached 46.5 per cent of the totals. The 1945 record of 41.5 per cent disease average for the State is only slightly below that of 1944. Obviously, the "milky" disease is playing a considerable part in reduction of Japanese beetle grub population where the bacterium has been established for a number of years.

[1] Garman, P., 1943; Conn. Agr. Expt. Sta. Bul. 472.

TABLE 22. RESULTS OF EXAMINATION OF MILKY DISEASE EXPERIMENTAL PLOTS, 1945

Location of experiment	Date experiment was established	Date of examination	No. grubs found	Ave. grubs per sq. ft.	No. grubs examined	No. grubs diseased
Seaside Park Bridgeport Plot C	Oct. 17, 1939	June 18	0	0	0	0
Tamarack Country Club Greenwich	Nov. 7, 1940	June 20	24	1.2	22	2
Cummings Park Stamford	Oct. 29, 1940	June 22	8	2.5	8	1
Brooklawn Country Club Bridgeport	Oct. 26, 1940	June 25	1	.04	1	0
Stamford Hospital	May, 1941	June 26	0	0	0	0
Keney Park Hartford	May 13, 1940	June 27	16	1.2	15	7
East Hartford Country Club	May, 1941	June 29	32	2.6	31	22

TABLE 23. CHECK (UNTREATED) PLOTS, 1945

Location of experiment	Date experiment related to check was established	Date of examination	No. grubs found	Ave. grubs per sq. ft.	No. grubs examined	No. grubs diseased
Seaside Park Bridgeport Plot C	Oct. 17, 1939	June 18	20	2	7	2
Tamarack Country Club Greenwich	Nov. 7, 1940 Check 600 ft. from experiment	June 20	17	2.8	15	0
Cummings Park Stamford	Oct. 29, 1940 Check 150 ft. from experiment	June 22	1	14	1	1
Brooklawn Country Club Bridgeport	Oct. 26, 1940 Check 100 ft. from experiment	June 25	8	1	8	4
Stamford Hospital	May, 1941 Check 100 ft. from experiment	June 26	5	1.6	5	0
East Hartford Country Club	May, 1941 Check 450 ft. from experiment	June 29	4	2	4	0

TOLERANCE OF GREENHOUSE BENCH ROSES TO DDT IN THE SOIL

J. P. Johnson

The soil in the benches of growing greenhouse roses was treated with DDT at various concentrations to observe the tolerance of the plants to the insecticide. This work was done in the greenhouses of A. N. Pierson, Inc., Cromwell, Conn. A 3 per cent DDT dust (Gesarol A-3 Dust), having talc as a carrier, was applied to the surface of the soil and watered shortly after the application. The soil, especially that in the benches containing the older plants, contained a large amount of organic matter as the beds had been mulched regularly with cow manure. In each treatment the rate of insecticide applied per acre is expressed in active DDT and does not include the carrier.

Named varieties were treated in the months of March and April, 1945, as follows: "Pink Beauty", one to two years old, in plots of 52 square feet each, was treated at the rate of 25, 50 and 87.2 pounds of DDT per acre. Young stock in 12 square feet of bench area, of the variety "Better Times", planted three weeks, was treated with DDT at the rate of 25 pounds per acre. A total of 33 square feet of "Better Times", two to three years old, in plots of 25 square feet each, was treated at the rate of 10, 15, 20 and 25 pounds per acre, while other plots consisting of 50 square feet of bench area received 50 and 87.2 pounds per acre. The variety "Starlight", two to three years old, in plots of 52 square feet each, was treated with 10, 15, 20, 25, 50 and 87.2 pounds of DDT per acre. "Pink Delight", two to three years old, in plots of 25 square feet, was treated at the rate of 10, 15, 20, 25 and 50 pounds per acre. In each case all of the plants, when compared with the untreated control plants, grew and flowered normally.

A METHOD OF APPLYING MILKY DISEASE SPORE DUST

R. L. Beard

For the artificial dissemination of milky disease among Japanese beetle larvae, spores of *Bacillus popilliae* Dutky are incorporated in a talc dust mixture as developed by the Bureau of Entomology and Plant Quarantine and described by White and Dutky (1940, 1942) and Dutky (1942). When this spore dust is applied on turf areas containing heavy populations of Japanese beetle larvae, the disease, under favorable conditions, may become a major factor of control. One disadvantage of this means of control is its slowness of action. Under Connecticut conditions, satisfactory reductions of larval populations by milky disease are rarely observed in less than three years. One factor contributing to this slow action is believed to be that the spore dust, being insoluble, may remain on the surface of the ground for long periods, particularly during the absence of rains, and the bacteria are thus not carried down to the feeding level of the grubs. Moreover, when the spores remain on the surface of the soil, they must

be subject to the deleterious effects of ultra-violet light, even though they are partially protected by blades of grass or particles of talc.

For the purpose of shortening the time that spores would remain on the soil surface after application, attention was directed toward processing the spores in a soluble carrier so that soil moisture, dew, or certainly rainfall, would release the spores into the soil as quickly as possible. It was further felt that for ease in handling, such a soluble preparation could be put in tablet form. By incorporating a heavy concentration of spores in the product, each tablet could serve for each spot treatment, which is, as commonly practised, 200,000,000 spores per spot (2 grams of spore dust). In application, the tablet could be dropped in the desired spot, or being soluble, could be dissolved in water and applied as a water suspension of spores for even more prompt introduction into the soil.

A satisfactory spore tablet has been developed which can be prepared in the following manner:[1] In the absence of suitable culturing methods, beetle grubs infected with the mature spore forms of *Bacillus popilliae* must serve as the source of spores. Diseased grubs are ground up in a meat chopper or mortar and pestle, to release the spores. The macerated material is then washed through a fine screen to remove the coarser particles, then through bolting cloth, and finally through coarse filter paper. With adequate washing, a relatively small number of spores are lost in the filtering process, and the filtrate contains an unobjectionable amount of foreign matter. If facilities are available, it is desirable to centrifuge the filtrate at once. Otherwise, the filtrate can be placed in a settling tower and refrigerated. In either case, when the spores settle to the bottom of the tower or centrifuge tube, the supernatant fluid can be decanted, leaving a paste of almost pure spores. It is not necessary, nor desirable, to dry the spores further at this point as they should be moist when added to the carrier.

The choice of carrier or carriers is somewhat limited, for although it should be soluble, it should not be so hygroscopic that it will not function well in the tablet-making machine. It must be non-toxic to the bacteria. Its physical nature must be such as to permit granulation, as a powder does not feed well in the machine, and it must be sufficiently adhesive to press well. While cost would be an item in commercial work, this method of processing permits such high concentration of spores per unit volume of carrier that a material of higher cost is permissible than where bulk quantities are used as with the dust mixtures.

The carrier that has seemed to work well is a mixture of dextrose and sodium bicarbonate. Dextrose by itself is too hygroscopic to make a good tablet. Also, tablets made of this alone are attractive to ants. Although this might be an advantage in breaking up the tablet

[1] The writer is indebted to Mr. Lawrence Nolan for helpful advice and assistance in formulating the tablets.

rapidly, it is believed that the ants might carry the spores too deeply into the soil to be effective against grubs. Sodium bicarbonate by itself forms a good tablet, but it is less soluble than dextrose. Even though tablets containing sodium bicarbonate dissolve more slowly than those containing dextrose alone, they do crumble and break down in the presence of moisture more rapidly. A mixture of approximately 60 per cent sodium bicarbonate and 40 per cent dextrose seems to form a satisfactory tablet. Undoubtedly, there are other soluble materials that would serve equally well.

The spore "paste" can be added to a reasonably small quantity of the carrier and thoroughly mixed. The quantity of carrier used should be sufficient to take up any excess water, and the result should be a moist, uniform mass. This is then dried in a desiccator. The spore content of the mixture can then be determined by dissolving a given quantity of the mixture, expressed in terms of dry weight, in a known volume of water and counting the spores in a counting chamber according to the usual technique. More of the carrier is then added to the mixture to bring it to the desired dilution. A small amount of moisture is added to the mixture to form an adhering, but friable, material. This is necessary in order to insure a homogeneous preparation instead of an admixture of the three separate components. To granulate, the moist material is then sifted through a wire screen of 24 mesh or finer, and spread as thinly as convenient on a flat container and dried in a desiccator. Heat, of course, cannot be used for drying. It is advisable to stir the material from time to time while drying to prevent the formation of lumps. Also, care should be taken so that the material is not reduced to a powder. For satisfactory results, it is essential that a granular material of uniform particle size and thoroughly dry be obtained. It can then be pressed into tablets in a tablet-making machine. The size of the tablet can be adjusted, by considering the concentration of the spores in the mixture, to contain the desired number of spores.

One disadvantage of this method is that the tablets are not strictly uniform due to the nature of the pressing process. Variation is minimized when the preparation has been thoroughly mixed and is of uniform particle size, but some variation is probably unavoidable. This is not a serious matter when numbers of tablets are used, as the average is maintained, but in an individual tablet, there is always the possibility of there being an excess or a shortage of spores when compared with any other tablet. For field application this would not be serious, as undoubtedly the individual spot treatments of dust vary as much as would the tablets, but for laboratory testing, the variation in tablets should be kept in mind.

Spore tablets prepared as described accomplish very well the purpose of getting the spores into the soil promptly. A tablet placed on the surface of the ground will normally disappear within two or three days even when no rain has fallen. Soil moisture and dew are

adequate to break down the material. When rain is falling, a tablet will disappear within a matter of hours. On the other hand, spore dust may remain in sight for weeks, or even months, even when some rain has fallen.

Experience has shown that it is difficult to compare the potency of spores prepared in tablet form with those prepared in dust form and those unprocessed. A critical test could be made only if a given lot of spores was divided into three portions—one to be tested without preparation, one made into tablets and tested, and the third portion made into dust and tested. This has not been possible in the writer's laboratory.

Certain tests have been made which, in general, indicate that the potency of spores in tablets is about equal to those in dust preparations. In one such test, dosages of 1,200,000,000, 600,000,000, and 300,000,000 spores were each added to 70 cubic inches of soil. In one series, spore dust (supplied by the Bureau of Entomology and Plant Quarantine) was used and, in another series, spore tablets were used. In each sample, 40 cc. of water were used to aid in distributing the spores. Each sample was thoroughly mixed in a small barrel-type mixer. Forty grubs were then added to each sample and incubated for 17 days at a temperature of 78° F. Added grass seed provided food for the grubs. The resulting incidence of disease was as follows:

	Per cent of grubs diseased	
Spore dose	Tablets	Spore dust
1,200,000,000	15.2	11.5
600,000,000	2.7	3.6
300,000,000	0	0

In both cases the incidence of disease was less than expected, but clearly there is little difference between the two groups.

In another test, two groups of 100 grubs, each in 100 cubic inches of soil, were placed in boxes. On top of the soil in one box, one tablet, containing an estimated 150,000,000 spores, was centrally placed. In the other box, similarly placed, was spore dust containing an equivalent number of spores. Grass seed was added to provide food, and the grubs were incubated as before. In this test, at the end of 17 days, 41 per cent of the grubs were diseased in the box containing the tablet, and 8 per cent of the grubs were diseased in the box containing the spore dust.

In another test, made in the same way but using a probable 200,000,000 spores in dust form and an estimated 155,000,000 spores in tablet form, the order of results was reversed. Twenty-two per cent of the grubs were diseased in the box containing spore dust, while 9 per cent were diseased in the box containing the tablet. In this case the lower dosage may have been partly responsible for a lower incidence of disease in the box containing the tablet, but also the spores may have had lower potency.

One batch of tablets indicated reduced potency, but this was definitely due to the low potency of the spores that were processed and not to the processing itself. In this case a portion of the spores were not processed, and tests made on these indicated the same low infectivity as shown by the spores processed into tablets.

Another batch of tablets yielded poor results, but no unprocessed spores of this lot were saved for comparison. In this case the low potency may have been due to the preparation, for the original formulation of carrier was not satisfactory for tablet making, and the material was modified and reprocessed several times.

The potency of the spores has not been tested for each stage of the tablet-making process, but spores in the dried granular material ready for pressing into tablets showed a negligible loss of infectivity as compared with the spores from the same source, but not mixed with any carrier. This check was made by injecting grubs with the spores in question.

During the time the tablet is actually dissolving, the contained spores are practically in a syrup and might be subject to great osmotic forces. To check on the possible effect of osmosis on spore potency, a tablet was placed in a test tube and moistened with a drop or two of water. The tablet did not completely dissolve, but it did break down to a very viscous drop. After nine days in this condition, the spores were further diluted and, in a dosage series, injected into grubs. Forty grubs were used for each dosage. These were incubated for two weeks, with the resulting incidence of disease being as follows:

Spore dosage	Per cent of grubs diseased
19,000	100
9,000	88
5,000	83
2,300	74
0	0

This indicated a high potency of the spores, in fact higher than was observed in a group of grubs similarly injected with unprocessed spores from another source.

Although the tests on the spore tablet product have not been exhaustive, it seems reasonable to conclude that spores of *B. popilliae* processed in this way provide a satisfactory means of introducing milky disease among a population of Japanese beetle grubs.

The only functional advantage of such a product over the spore dust seems to be in the fact that the soluble tablet breaks down promptly, presumably allowing the spores to become incorporated in the soil more rapidly than the dust.

As a matter of convenience, the tablet seems to offer a number of advantages. In use, a tablet can be dropped more easily than putting out a measured dose of dust. If desired, the tablets could be dissolved in water, and the spore suspensions applied to the soil. In packaging

and handling, tablets make a neater product than dust. If the tablets are made up to weigh about 200 milligrams, each containing 200,000,000 spores, one pound (2,265 tablets) would be equivalent to ten pounds of dust. In preparation, this would mean handling much less bulk of material. The writer has made tablets only on a laboratory scale, but there seems no reason why larger quantities cannot be prepared with equal facility. Aside from the tablet-making machine, and possibly a centrifuge, no special equipment is necessary for putting up the spores in this form.

The terms of U. S. Letters Patent No. 2,258,319, issued to the Secretary of Agriculture, which regulates the use of milky disease spore dust, are very broad and might be interpreted to cover such a bacterial product as the tablets described in this paper.

Literature Cited

DUTKY, S. R., 1942. Method for the preparation of spore-dust mixtures of Type A milky disease of Japanese beetle larvae for field inoculation. U. S. D. A. Bur. Ent. Pl. Quar. ET-192.

WHITE, R. T., AND S. R. DUTKY, 1940. Effect of the introduction of milky diseases on population of Japanese beetle larvae. *Jour. Econ. Ent.* 33:306-309.

WHITE, R. T., AND S. R. DUTKY, 1942. Cooperative distribution of organisms causing milky disease of Japanese beetle grubs. *Jour. Econ. Ent.* 35:679-682.

THE EFFECT OF TEMPERATURE UPON THE CONTROL OF THIRD INSTAR JAPANESE BEETLE LARVAE IN SOIL TREATED WITH LEAD ARSENATE

J. PETER JOHNSON

In Connecticut, lead arsenate is usually applied to turf, at the rate of 10 pounds to 1,000 square feet of area, to control larvae of the Japanese beetle. The treatment usually is effective for a period of three to five years. It has been the practice of many to delay the application of the insecticide until the turf is seriously threatened or damaged. As a result, lead arsenate has been applied at all times during the year with the possible exception of the winter months when the ground is frozen. Seasonal differences at the various times of application, therefore, have caused questions to arise concerning the influence of soil temperature upon control expectancy.

A study of the influence of temperature was made in 1941-1942 by treating soil with known amounts of lead arsenate, infesting the treated soil with third instar (nearly full grown) larvae and subjecting the material to different constant temperature levels, 57°, 67°, 77° and 87° Fahrenheit. The minimum of 57° F. was chosen because larval activity lessens below 60° F., and the maximum of 87° F. because it was above the usual mean soil temperature which occurs while the larvae are most prevalent. A constant temperature chamber, with a variation of ± 1° F., was used for each temperature level.

The soil used was a Wethersfield loam with the following composition[1]:

[1] All the soil analyses were made by the Soils Department of the Connecticut Agricultural Experiment Station.

Per cent total N	.1485%	Exch. K	74.8 p. p. m.	Per cent total sand	56.4%
C/N ratio[1]	12.4 to 1	Exch. Ca	1732 p. p. m.	Per cent total silt	34.4%
Carbon	1.852%	Exch. Mg	60.06 p. p. m.	Per cent total clay	9.2%
Per cent total P	.062%	Exch. H	2.1 M. E.[2] 100 gms.	pH	5.93
Available P	89.6 p.p.m.	B. E. C.[3]	8.8 M. E. 100 gms.	Moisture Equiv.	17.36%

Six samples of soil were taken in the field to determine the natural volume weight. Each sample consisted of a soil plug 250 c. c. in volume from which the turf had been removed. The average natural volume weight of the samples was 346 grams, while the dry weight was 290 grams.

Bulk soil for use in the experiment was obtained from the field and air-dried until friable. It was then screened to remove the stones and prepare it for weighing. Sufficient water was added to the soil used in each experimental unit so it contained a moisture content of 19.36 per cent, which was equivalent to that of its natural volume weight. Each test required 24 standard, four-inch, clay flower pots, each containing 692 grams of soil tamped and compressed into a cubic area of 500 c. c.

Lead arsenate was used at the rate of 5, 10, 20 and 40 pounds to 1,000 square feet of surface area mixed to a depth of three inches, or 218, 436, 872 and 1,744 pounds respectively to a three-inch acre. These rates of application were reduced to a cubic inch basis to determine the amounts required for mixing in the soil. For example, since each pot contained 500 c. c. or 30.51 cubic inches of soil, the amount of lead arsenate needed per pot at the 10-pound rate was 30.51 x 0.0105, or 0.32 grams.

The lead arsenate and soil required for a complete temperature series at each concentration was uniformly mixed on a concrete floor by turning and mixing 12 times with a sand shovel. As the relative weight of the lead arsenate in each mixture was exceedingly small, it was disregarded when weighing the material for the individual pots. The pots were then placed in the temperature chambers for 24 hours before infesting with third-instar larvae. Four holes 1½ inches in depth and ¼ inch in diameter were punched in the soil of each pot, each hole infested with one larva and covered with soil.

Loss of soil moisture through evaporation was corrected by weighing all pots three times a week at the 87° and 77° F. temperature levels and twice a week at the 67° and 57° F. levels and adding sufficient water to restore the moisture content to approximately 19 per cent. Larval mortality was recorded after 3½ and seven days and then at weekly intervals until all larvae in the treated soil were dead. After each examination, the soil was immediately replaced in the pot, tamped and compressed as before, reinfested with the surviving larvae, and returned to the temperature chamber.

[1] C/N Ratio = Carbon Nitrogen Ratio.
[2] M. E. = Millegram Equivalent.
[3] B. E. C. = Base Exchange Capacity.

The results are given in Table 24.

TABLE 24. MORTALITY OF THIRD INSTAR JAPANESE BEETLE LARVAE IN SOIL TREATED WITH LEAD ARSENATE AND MAINTAINED AT TEMPERATURES OF 87°, 77°, 67° AND 57° F.

	87° F.					77° F.					67° F.					57° F.			
		Pounds					Pounds					Pounds					Pounds		
Days	Check	5	10	20	40	Check	5	10	20	40	Check	5	10	20	40	Check	10	20	40
	Number dead					Number dead					Number dead					Number dead			
3½	5	5	13	33	62	5	10	6	19	47	8	4	10	15	12	2	0	1	0
7	2	1	2	18	23	1	8	4	37	45	1	0	1	7	16	3	4	3	3
14	5	3	13	22	4	0	6	12	13	1	2	7	7	30	58	1	3	2	17
21	4	11	29	17	7	3	5	12	15	1	0	5	8	15	5	1	3	9	45
28	8	25	32	6		9	21	26	6	0	0	5	11	11	3	0	5	18	28
35	11	17	6			11	11	21	6	2	2	10	13	6	1	3	3	18	0
42	16	9	0			15	11	13			4	6	9	5	0	0	3	5	1
49	16	11	1			9	9	0			6	3	10	5	1	0	4	10	2
56	9	8				6	5	1			3	9	9	0		7	3	8	
63	9	2				11	5	1			12	8	8	0		2	3	4	
70	4	2				4	5				6	7	2	2		8	11	4	
77	2	1									6	1	3			2	16	3	
84	1	1									6	8	2			2	14	2	
91											7	4	1			15	7	3	
98											4	4	1			0	5	2	
105											7	5	0			3	5	0	
112											4	4	0			2	2	1	
119											4	1	1			6	2	1	
126											4	3				8	1	0	
133											2	1				3	1	1	
140											5	1				11	1	0	
147																3		0	
154																2		1	
Totals	92	96	96	96	96	74	96	96	96	96	93	96	96	96	96	84	96	96	96

The frequencies in each column of Table 24 were transformed to cumulated percentage frequencies and these, in turn, to probits (1). The probits were plotted against the logarithm of the length of survival time in days. The expected time (in logs) required to kill given proportions of larvae (in probits) was interpolated at each dosage of lead arsenate and temperature. When the interpolated log-times at each temperature were related to the log-dose, approximately parallel dosage-response curves were obtained at the 65, 75, 85 and 90 per cent levels of mortality. The series at the 85 per cent level was slightly steeper and the interpolated results are given in Table 25 after converting from logs to days.

TABLE 25. EXPOSURE TIME IN DAYS FOR 85 PER CENT MORTALITY OF THIRD INSTAR LARVAE

	Pounds of lead arsenate			
Temp.	5	10	20	40
57° F.		93.5	67.7	26.9
67° F.	95.5	58.9	30.9	14.1
77° F.	54.9	35.4	18.6	5.6
87° F.	46.7	26.9	16.2	6.1

The values which have been changed in original units in Table 25 have been plotted against the log-dose in pounds (Figure 16). The interpolated points for each temperature were fitted with parallel lines by the method of least squares.

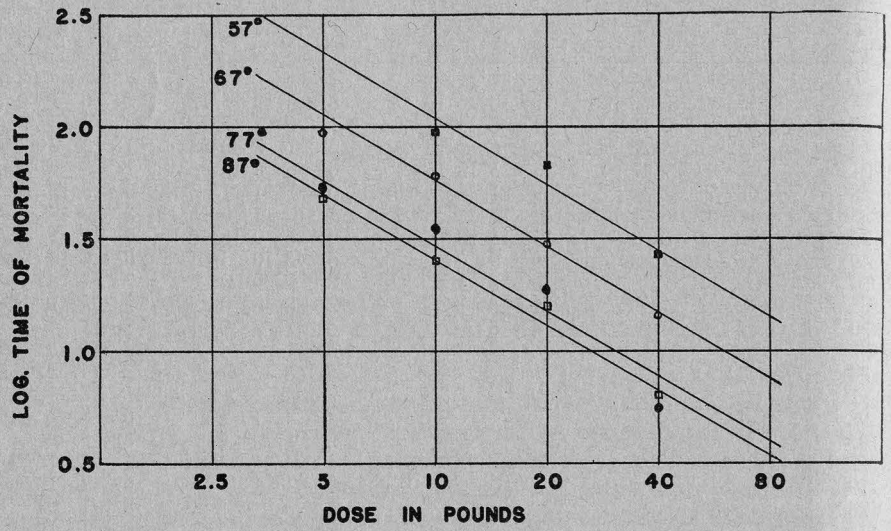


Figure 16. Relation of exposure time, in logarithms, necessary to kill 85 per cent of the larvae to dose of lead arsenate per 1000 square feet, at different temperatures in degrees Fahrenheit.

The results obtained agree in the main with those obtained by Fleming (2). The differences were caused primarily by the different techniques and temperatures used.

Conclusions

At the temperatures tested, the logarithm of the lethal dose of lead arsenate varied inversely with the logarithm of exposure time.

For any given length of treatment, the amount of lead arsenate required to kill 75 per cent of the larvae at 67° F. was twice that needed at 77° F. Likewise, twice the amount was required at 57° F. as at 67° F. Between 77° F. and 87° F. there was little difference in the necessary dosage for the same length of treatment.

Literature Cited

(1) Bliss, C. I., The Calculation of the Time-Mortality Curve. Appendix by W. L. Stevens. Ann. Applied Biology, Vol. 24, pp. 815-852, 1937.

(2) Fleming, W. E., Influence of Temperature on Effectiveness of Lead Arsenate against Larvae of the Japanese Beetle in the Soil. U. S. D. A., B. E. P. Q., E-622, July 1944.

EXPERIMENTAL CONTROL OF ORCHARD INSECTS

Philip Garman

Experiments in fruit insect control during 1945 were designed to answer some of the many problems facing Connecticut growers. Work with DDT on apples, peaches, quinces and pears included tests with supplements for European red mite control, as well as control of the oriental fruit moth, quince curculio, seventeen-year locust, pear psylla and apple maggot. General conclusions after two years' work are as follows: DDT is a good insecticide which will be useful, certainly on quinces, probably on peaches, possibly on apples, and probably not at all on pears. The very good control of codling moth obtained by other workers indicates at least that it may be used on apples in emergencies such as developed this year. The main factors operating against its speedy adoption for apples lies in negative red mite, poor curculio and the, as yet, doubtful maggot control (Table 32). Its use on quinces appears desirable (Table 35) as soon as the material is commercially available. For peaches, our experiments indicate that it is promising for the oriental fruit moth. It is known to be destructive to parasites, but there is no reason why successful schedules cannot be devised to give maximum protection with minimum destruction of parasites.

Apples

Continued experimentation with heavy-dose, reduced schedules gave promising results for Baldwin, Rome and Delicious (Tables 26, 27, 28), but results were not entirely satisfactory for McIntosh (Tables 29, 30), Duchess or Staymen Winesap. Increasing the fungicide from 1.5 to three pounds per 100 gallons gave an increase in protection from scab, as might be expected, but an increase in lead ar-

Table 26. Control of Apple Pests with Reduced Sprays. 1945
Burton Orchard
Baldwin

	Treatment Amounts in lbs. per 100 gals.				Per cent free of insect and disease blemishes	Per cent severe russet
	Lead arsenate	Fermate	Bentonite	Veegum[1]		
(1)	6	1½	2	..	97.25	7.85
(2)	9	1½	2	..	96.39	7.71
(3)	6	1½	..	5	94.46	5.71
(4)	9	1½	..	5	95.93	16.88
(5)	6	3	2	..	95.09	5.01
(6)	9	3	2	..	98.11	9.35
(7)	6	3	..	5	97.15	15.11
(8)	9	3	..	5	95.62	7.90

Spray dates: April 12-13, April 30, May 22. Maggot dust: July 30.
½ lb. skim milk powder added to all treatments.

[1] Trade name for aluminum magnesium silicate gel.

Notes: (1) Disease and insect control satisfactory.
(2) Differences in amount of russetting not significant.
(3) One and one-half pounds Fermate to 100 gallons is ample for this orchard.
(4) Six pounds of lead arsenate is sufficient for the insects present in 1945.

TABLE 27. GENERAL PEST CONTROL WITH REDUCED SPRAYS. 1945
Westwoods
Romes

Treatment, lbs. in 100 gals.		Tree	Per cent clean externally	Per cent maggot	Per cent curculio	Per cent scab
Lead arsenate	6 lbs.	J 20	81.65	5.39	.77	10.95
Fermate	1½ lbs.					
Skim milk	½ lb.	J 21	92.51	7.90	.06	4.79
White oil	2 qts.					
Veegum	5 lbs.	J 22	87.98	20.41	.83	6.63
Nicotine sulfate	1 pt. in first spray					
Lead arsenate	6 lbs.	J 27	89.96	6.78	.00	5.02
Bentonite	3 lbs.					
Skim milk	½ lb.	J 29	94.59	9.82	.05	5.36
White oil	2 qts.					
Fermate	1½ lbs.					
Nicotine sulfate	1 pt. in first spray					
	Average		89.34	10.06	.034	6.55

Spray dates: April 13-14, May 2, May 24, June 7.

TABLE 28. CONTROL OF APPLE PESTS WITH REDUCED SPRAYS. 1945
Burton Orchard
Delicious

Treatment Amounts in lbs. per 100 gals.					Per cent clean	Per cent scab
Lead arsenate	Fermate	Bentonite	Veegum	Skim milk		
6	1½	..	5	½	94.40	2.17
6	1½	2	..	½	94.31	.59

Spray dates: April 12-13, April 30, May 22. Maggot dust: July 30.

Notes: (1) Little or no russet apparent on examination.
(2) Disease and insect control satisfactory.

senate from six to nine pounds per 100 gallons reduced the effectiveness of the mixture. However, with the best treatments, 73 per cent of the trees yielded 85 per cent clean fruit or better. Maggot control was satisfactory in the Burton orchard where a late July dust was applied, but it was not entirely satisfactory on all varieties in the more heavily infested Westwoods orchard where no such late treatment was given. This year was wet throughout the summer, and both scab and apple maggot were problems in the experimental blocks.

A few dormant scale control tests in Westwoods gave good scale reduction with various commercial oils, plus nicotine sulfate or DN[1] solution. These tests, made at the green tip stage of development, later than commonly recommended for DN, caused some bud scorch where DN and oil were used in combination, but none where the materials were applied separately or when oil was combined with nico-

[1] Dinitro-o-cresol.

TABLE 29. CONTROL OF APPLE PESTS WITH REDUCED SPRAYS. 1945
Burton Orchard
McIntosh

	Treatment Amounts in lbs. per 100 gals.				Per cent clean	Per cent scab
	Lead arsenate	Fermate	Bentonite	Veegum		
(1)	6	1½	2	..	78.79	19.81
(2)	9	1½	2	..	52.76	46.07
(3)	6	1½	..	5	59.09	40.02
(4)	9	1½	..	5	61.10	37.80
(5)	6	3	2	..	85.23	13.77
(6)	9	3	2	..	81.29	17.21
(7)	6	3	..	5	89.53	7.78
(8)	9	3	..	5	60.49	38.43

Spray dates: April 12-13, April 30, May 22. Maggot dust: July 30.
½ lb. skim milk powder added to all treatments.

Notes: (1) Scab control unsatisfactory.
(2) Scab control better with 3 lbs. Fermate to 100 gals. compared with 1½.
(3) Scab control slightly better with bentonite.
(4) Scab control better where 6 lbs. lead arsenate was used instead of 9.
(5) 19 trees out of 26 (or 73%) receiving 3 lbs. Fermate per 100 gals. were above 85% in clean fruit.
(6) 9 trees out of 27 (or 33%) receiving 1½ lbs. Fermate per 100 gals. were above 85% in clean fruit.

TABLE 30. GENERAL PEST CONTROL WITH REDUCED SPRAYS. 1945
Westwoods
McIntosh

Treatment, lbs. in 100 gals.		Tree	Per cent clean externally	Per cent scab	Per cent curculio	Per cent maggot[1]
Lead arsenate	6 lbs.	H 20	51.82	42.91	.81	9.0
Fermate	1½ lbs.	I 16	69.13	27.86	.90	0.0
Skim milk	½ lb.	K 19	73.53	23.52	.00	12.0
White oil	2 qts.	M 14	73.25	24.25	.00	0.0
Veegum	5 lbs.	O 16	68.18	29.87	1.30	11.1
Nicotine sulfate	1 pt. in first spray					
	Average		67.18	29.68	.60	6.4
Lead arsenate	6 lbs.	M 26	86.00	13.88	.00	6.0
Bentonite	3 lbs.	K 25	57.73	41.15	.00	15.0
Skim milk	½ lb.	J 25	82.42	15.12	.70	0.0
White oil	2 qts.	J 23	77.84	20.24	1.80	9.6
Fermate	1½ lbs.	J 33	80.79	15.23	.00	0.0
Nicotine sulfate	1 pt. in first spray					
	Average		76.96	23.90	.50	7.8

Spray dates: April 13-14, May 2, May 24, June 7.

[1] Drop counts only. Picked counts average about half these figures.

tine sulfate. A commercial miscible oil plus two quarts of DN solution was particularly effective in reducing the infestation.

A cooperative experiment with Doctor Kerr of the United States Rubber Company, Naugatuck Chemical Division, gave promising results for red mite control where DDT was used as the insecticide. The experiment did not begin to show results this year until after

TABLE 31. EUROPEAN RED MITE CONTROL ON APPLES. 1945
Varieties — Baldwin, Rome

	Materials and concentration	Variety	Adult females per 20 leaves Aug. 11	Aug. 18	Aug. 27
(1)	DDT plus "72 E"	Rome	88	178	265
(2)	DDT in talc	Rome	226	679	572
(3)	Same as (1)	Baldwin	87	207	266
(4)	Same as (2)	Baldwin	484	918	676
(5)	DDT plus "72 E"	Rome	29	50	81
(6)	DDT in talc	Rome	376	481	297
(7)	Same as (5)	Baldwin	46	89	103
(8)	Same as (6)	Baldwin	158	566	549
	Totals for DDT–"72 E"		250	524	715
	Totals for DDT–talc		1,164	2,644	2,094

Explanation of treatments: Amounts per 100 gals.
(1) "72 E" containing 33 1/3% DDT 1 qt., plus flotation sulfur 8 lbs.
(2) DDT-talc containing 33 1/3% DDT 2.32 lbs., plus flotation sulfur 8 lbs.
(5) "72 E" 1 pt., plus flotation sulfur 8 lbs.
(6) DDT-talc 1.16 lbs., flotation sulfur 8 lbs.
Applications: April 14, May 5, 16, 26, June 9, 25-26, July 6, 26. Power sprayer —6 nozzle boom.

TABLE 32. EXPERIMENTS WITH MAGGOT CONTROL. 1945
Westwoods — Cortlands
DDT Dusts

Tree		Per cent maggoty 1943	1944	1945
B 2	Drops	100	13.5	95.09
	Picked		9.5	58.00
B 5	Drops	100	7.3	88.27
	Picked		5.6	38.00
B 9	Drops	100	20.7	50.0
	Picked		12.7	20.0
B 13	Drops	98	31.6	83.52
	Picked		17.0	38.00
B 17	Drops	93	14.4	71.69
	Picked		24.7	46.79

Treatments for maggot control:
1943 — None
1944 — Dusted with 3% DDT in talc July 3, 17, 28, August 10.
1945 — Dusted with 5% DDT in talc July 6, 26, August 8.

Notes: 1945—Dusts either not frequent enough or late enough. Rainy season, with flies coming in late.
1944—A light season for maggot, and dry.

August 1. At that time, comparisons of blocks treated with DDT and talc, and the same concentration of DDT with the special agent "72 E"[1] gave results distinctly in favor of the latter (Table 31). A pronounced difference in tree color was also noticeable between the two treatments about August 15.

A continuation of last year's tests with DDT dust for maggot control on Cortlands was disappointing. Last year, substantial control appeared to be obtained with four 3 per cent talc, DDT dusts, but three 5 per cent dusts applied this year were not nearly as successful (Table 32).

Peaches

Experiments in the Mount Carmel peach orchard showed the desirability of using basic lead arsenate plus wettable sulfur in early sprays against the plum curculio. The combination of early arsenate and late DDT applications in dust form was particularly gratifying in the production of a large amount of clean fruit (Tables 33, 34).

Quinces

In the quince planting, control of both quince curculio and oriental fruit moth, as well as fruit spot diseases, was obtained with a combination of oil, Fermate and DDT, the oil being emulsified with skim milk powder. Another preparation containing DDT dissolved in Velsicol[2] and emulsified with skim milk powder gave satisfactory insect control, but did not affect the fruit spot. A combination of lead arsenate and DDT was no more effective than DDT alone (Table 35).

TABLE 33. ORIENTAL FRUIT MOTH CONTROL IN ELBERTA PEACHES. 1945
Mount Carmel

	Treatment	Per cent fruit moth	Number of trees examined
(1)	Sulfur-oil dust (R. & H.) (no DDT)	13.56	8
(2)	Niagara sulfur-oil-DDT dust (3% DDT)	7.20	9
(3)	Sulfur + 5% DDT fused dust (no oil)	3.44	12
(4)	Sulfur + 5% DDT mixed dust (no oil)	1.48	7
(5)	Check – no dust for fruit moth	10.95	11

Dates of dust applications: July 11-12, August 9. Plot No. 1 received a third dusting on August 30. Remaining plots not treated on that date.

[1] An iso amylnaphthyl ether.
[2] Methyl naphthalene.

TABLE 34. PEACHES. CLEAN FRUIT ESTIMATES. 1945

Mount Carmel
Elbertas

Treatment	Tree	Total fruits on tree	Clean	Per cent clean
Basic lead arsenate 2 lbs.; flotation sulfur 8 lbs.; lime 16 lbs. – 100 gals. – 2 sprays 5% DDT-sulfur. Mixed dust, 2 applications	H 3	222	216	97.29
Same as above	H 4	199	190	95.47
Basic lead arsenate 4 lbs.; flotation sulfur 8 lbs.; lime 4 lbs. – 100 gallons – 2 sprays 5% DDT-sulfur. Mixed dust, 2 applications	D 3	452	380	84.07
Same as above	D 4	905	851	94.03
Same as above	A 15	588	535	90.98
Same as above	A 16	639	568	88.88
Totals		3,005	2,740	91.18
Flotation sulfur 8 lbs.; lime 4 lbs.; – 100 gallons – 2 sprays No late dusts	D 8	552	429	77.71
Flotation sulfur 8 lbs. – 100 gals. – 2 sprays Sulfur-oil dusts – 2 late applications	C 7	311	241	77.49
No early sprays 5% DDT-sulfur – 2 applications	E 9	665	496	74.59
Same as above	E 12	536	300	55.97
No early sprays Sulfur-oil dusts – 2 applications	B 2	350	124	35.43
Same as above	B 3	343	120	34.99
Fermate 1½ lbs.; lime 1½ lbs. –2 sprays early No late dusts	H 21	308	106	34.42
Same as above	H 22	476	174	36.55
Totals		3,541	1,990	56.20

TABLE 35. CONTROL OF QUINCE INSECTS. 1945
Percentages of Wormy Fruit from Trees Receiving Four Different Treatments.

(1) Tree	(1) Per cent	(2) Tree	(2) Per cent	(3) Tree	(3) Per cent	(4) Tree	(4) Per cent	(5) Tree	(5) Per cent
A 1	0.00	A 7	22.22	A 5	0.00	A 4	51.51	A 9	100.00
A 2	17.64	A 8	18.18	A 6	2.86	A 11	37.50	A 10	80.00
A 13	1.43	A 17	20.58	A 16	28.78	A 12	50.00	A 19	67.27
A 14	4.85	A 18	11.11					A 23	100.00
A 21	7.05								
A 22	5.71								
B 11	8.59	B 3	25.00	B 5	9.09	B 2	37.50	B 7	64.29
B 12	5.71	B 4	8.11	B 6	24.59	B 15	31.13	B 8	76.00
		B 9	23.72	B 13	16.67	B 16	47.47	B 17	100.00
		B 10	19.64	B 14	23.58			B 18	94.10
		B 20	29.14	B 23	28.57				
Av.	7.05		19.05		19.96		41.89		84.22

Explanation of treatments:

Materials and amounts per 100 gallons.

(1) DDT (25%) 6 lbs., Fermate 1½ lbs., skim milk powder ½ lb., white mineral oil ½ gallon. Spray dates: June 7, July 7, August 10.

(2) DDT (25%) 3 lbs., lead arsenate 3 lbs., skim milk powder ½ lb., Fermate 1½ lbs., white mineral oil ½ gal. (omitted from last spray), Veegum 5 lbs. Spray dates: June 7, July 7, August 10.

(3) DDT (pure) 1 lb., Velsicol solvent 1 qt., skim milk powder ½ lb. Spray dates: June 7, July 7, August 10.

(4) Lead arsenate 6 lbs., Fermate 1½ lbs., skim milk powder ½ lb., Veegum 5 lbs., white mineral oil ½ gal. (omitted from last spray). Spray dates: June 7, July 7, August 10.

(5) Check, no treatment.

Pears

In a cooperative test with the United States Bureau of Entomology and Plant Quarantine, it was shown (Table 36) that pear psylla adults could be destroyed effectively in October with nicotine alkaloid dissolved in kerosene and atomized onto the trees with special blowers. A solution of one pint alkaloid per gallon of oil applied at the rate of five to 10 ounces per tree gave 95 per cent kill in a number of separate tests. The material was also atomized in the air stream of a commercial duster under pressure from a small paint sprayer. Results were equally good. The plan of this experiment consisted of spraying, then counting the psylla dropped on five paper pie plates placed underneath the trees; blowing the trees without spray to dislodge those killed by the first spray but not falling to the ground, then respraying the trees with 32 ounces per gallon of kerosene, a dose which removes 98 per cent (for practical purposes here considered as 100 per cent) of those remaining. The population on the tree at the beginning of the experiment is then estimated by simple addition.

It was also learned in the course of these experiments that 3 per cent nicotine dust was much more effective for killing adult psylla than 5 per cent DDT and that the spray treatments of nicotine alka-

loid in kerosene destroyed a large percentage of fifth instar nymphs. There also appears to be a distinct fumigation effect by the volatile nicotine which does not have to come into direct contact with the adult psylla to kill them.

Dr. D. W. Hamilton, K. A. Haynes, William Holland and John Smith cooperated and were responsible for most of the work involved. Thanks are also due to the owner, A. T. Henry, for the use of the orchard, and to his son, David, who operated the tractor throughout these tests.

TABLE 36. PEAR PSYLLA CONTROL EXPERIMENTS. OCT. 4, 1945
A. T. Henry's Orchard, Wallingford

Oz. alkaloid per gallon	Oz. applied per tree	First knockdown	Second knockdown	Per cent control by first application
Adult knockdown with nicotine alkaloid in water solution plus 20 oz./gal. B 1956 spreader				
2	17.0	617	61	66.8
4	7.4	954	83	69.7
8	1.5	76	99	43.4
16	5.6	159	41	79.50
32	2.3	142	24	85.54
Knockdown with nicotine alkaloid in kerosene solution				
2	7.8	287	25	74.2
4	7.5	421	71	87.5
8	6.5	87	7	92.5
16	8.0	178	5	97.3
32	7.1	277	20	98.6

NOTES ON THE BIOLOGY OF THE CODLING MOTH IN CONNECTICUT

J. F. TOWNSEND

The unusual weather conditions in 1945 apparently spread out the emergence of over-wintered stock over an unusually long period, with low temperatures unfavorable for oviposition by the earlier moths, delay of a large proportion of moths until the more favorable warm weather of late June and July, and the consequent hatching of a large proportion of the first generation larvae at a time later than commonly expected in planning insecticide coverage against this insect in Connecticut. Most of the damage occurred after the first of July, in a period when insecticide coverage had become much reduced in most orchards. The damage was more severe than usual for the State in general, and particularly so in several large commercial orchards.

Late hatching of an important part of first brood larvae has probably been much more frequent than generally realized, having largely escaped notice in commercial orchards in the former periods of low

population levels. Examination of past temperature records in the light of seasonal life history studies in Connecticut and nearby regions suggests that hatching of at least one-third of the first generation larvae may have occurred as late as July in 13 out of the last 27 years. More attention to insecticide coverage throughout June and July seems indicated if the insect continues to cause substantial damage.

Several additional factors may have had an important bearing on the codling moth problem. A tendency toward an increase of the insect, resulting from summer temperatures above normal for the past 15 years, is logical to expect from similar experience in the 1870's, before insecticides were commonly used. The overgrown condition of many orchard blocks, following several years of labor shortage, has greatly increased the difficulty of thorough insecticide applications, and in some instances has seemed obviously a factor in the poor control obtained. The purchase of infested apple boxes from the New York market has undoubtedly increased the moth population in certain orchards, particularly in the vicinity of storages. It is feared that some of the introduced moths may have been of strains more resistant to arsenate of lead than the local moths, but nothing is definitely known on the subject.

Satisfactory control with an arsenate of lead schedule was obtained as usual in many orchards, including the two small orchards handled by the Experiment Station. In one commercial orchard under close observation, codling moth damage declined markedly from the higher levels of previous years, following some improvement in general orchard methods, but particularly in the thoroughness of the lead arsenate sprays.

On the question of increased resistance of the insect to lead arsenate in Connecticut, no definite evidence is as yet available to warrant the widespread assumption that such an increase in resistance has occurred. More definite information on the subject seems needed both in the study of the biology of the codling moth and in its control.

COMMERCIAL NURSERY CONTROL OF THE PEACH TREE BORER

PHILIP P. WALLACE[1]

The culling of finished two-year-old peach trees because of peach tree borer infestation observed at the time of digging for sale is one of the most serious economic problems in the commercial propagation of peach trees in the northeastern United States. The loss is seldom less than 20 per cent and often as much as 50 to 60 per cent of the budded stock at two years from seed.

In this section the pits are planted in early spring and the plants are budded in August of the same year. In late spring of the following year the top above the bud is cut off and the bud shoot grows

[1] See footnote 1, page 33.

vigorously so that the plants are generally finished by the end of the second season. They are dug in late fall, stored in packing sheds during the winter, and sold for transplanting the following spring, two years from seed.

Three- to four-month-old seedlings may be attacked by the borer if the local infestation is high, and at this stage the small plants are likely to die or be seriously injured. Most injury of commercial importance, however, results from attack during the early summer of the second season when the plants are about 15 months old, with a bud shoot three feet tall and one-half inch in diameter.

Life History and Habits

The peach tree borer is the larva of a clear-wing moth belonging to a family known as the Aegeriidae, superficially somewhat resembling a large, metallic-blue wasp.

There is one generation a year. Adults first appear in southern Connecticut during the last week of June or the first of July. Although most of the eggs are deposited by the third week in July, adults continue to emerge throughout the summer and some egg laying extends until frost. The eggs are deposited on the surface of the stems and leaves of the peach and are occasionally found on other material close to or on the ground.

As soon as a larva emerges from the egg it travels at once down the stem. At a location generally not more than an inch or two above or below the ground level the larva bores through the bark, and the remainder of its development is passed within the stem or root of the plant.

Infestation is indicated by a heavy, gummy exudation mixed with frass. However, injuries of many kinds may cause a similar exudation and small larvae may not cause enough gum and frass to be readily noticed. So for positive identification it is often necessary to cut away part of the stem, thus ruining the tree for sale regardless of the presence of borers.

Control

A reasonable combination of good management, sanitation, and chemical treatment will entirely eliminate commercial loss from the peach tree borer in nursery plantings.

The most common and obvious source of infestation is the stumps of discarded seedlings which are often neglected in cleaning up and are left or plowed under. The peach tree borer breeds not only in peach but in plum, wild cherry, chokecherry and others of the Prunus group, and the moths sometimes fly a mile to deposit their eggs. It is

therefore essential to eradicate permanently all these sources of possible infestation and to isolate and rotate plantings as much as practical.

There are two stages in development when the larvae can be killed, and a different type of chemical treatment is required for each. (1) During the period between emergence of the young larva from the egg and before it enters the trunk, it is susceptible to contact poisons. Nicotine or pyrethrum are excellent contact poisons but the duration of toxicity of these sprays is generally limited to a few hours. However, if a poison with long residual toxicity, such as DDT, is applied, the larva must come in close contact with the toxic deposit while crawling down to the base of the trunk. (2) In late August or early September most of the eggs have been deposited and the borers are established in the trunk near the base of the plant. Soil treatment with the proper fumigant shortly after this will destroy practically all the borers. Unfortunately, the borers may already have caused extensive damage to some of the trees, although the most serious injury occurs when the borers are larger, from the middle of September till the ground freezes and from the first of May until they transform to adult moths in late June.

It has been known for a long time that certain fumigants, particularly paradichlorobenzene and ethylene dichloride, are effective soil treatments for killing peach tree borers. The use of these chemicals on young trees has been tested, and it is known that under certain conditions serious injury may result from using the commonly recommended dosage. The effectiveness of DDT against the peach tree borer on large trees has been indicated but the use of a residual DDT spray for commercial nursery peach plantings has not been reported.

Investigations here have been directed toward determining: (1) a soil fumigant treatment which even under very unfavorable conditions is safe and effective, and (2) the effectiveness of DDT spray treatments for control of the peach tree borer in seedling peaches growing in a commercial nursery.

DDT Spray Tests

DDT, technical grade, was dissolved in Velsicol AR 50 (mono and dimethyl naphthalenes) and emulsified with Emulphor E. L. (a condensation product of ethylene oxide and an organic acid) in water to make a stock emulsion. The spray was applied with a hand pressure tank sprayer having a nozzle opening of .045 inch diameter which gave a narrow spray cone and supplied a large volume at satisfactory pressure. Only the base of the trunk and lower branches were sprayed, although some of the lower leaves were unavoidably wetted. The trees were sprayed from both sides of the row and only one application was made during the season, on June 23 at Ellington.

The peaches were 14 months old, budded in August of the preceding year and had a stock diameter of one-half inch and bud shoot three feet tall, three-eighths inch diameter[1]. In a two-acre field, four plots were chosen at random, each consisting of 49 trees in a row. The first seven trees in each plot received treatment number 1; the next seven, treatment number 2, etc. Seven trees in each of four plots, 28 in all, thus received the same treatment. All trees were dug and examined in early November.

The dosage series applied was based on results of laboratory tests. An emulsion was used because the DDT did not settle and it contained a minimum of material which might be phytotoxic.

The information obtained from these trials (Table 37) indicates that DDT applied as an emulsion in late June at the rate of three pounds per 100 gallons gave effective control of the peach tree borer. At lower concentrations, control was diminished. It appears from these tests that adding bentonite to the mixture increased its effectiveness.

TABLE 37. DDT TREATMENTS FOR CONTROL OF THE PEACH TREE BORER
Each test constitutes 4 replicates of 7 two-year trees
Spray volume: approximately 0.5 oz./tree

Concentration per 100 gals. water	Total trees	No. trees infested	Total borers	Per cent trees infested
¾ lb. DDT	28	4	7	14
¾ lb. DDT + ¾ lb. bentonite	28	1	1	3.5
1½ lbs. DDT	28	1	2	3.5
1½ lbs. DDT + 1½ lbs. bentonite	28	0	0	0
3 lbs. DDT	28	0	0	0
3 lbs. DDT + 3 lbs. bentonite	28	0	0	0
Control	28	10	13	35.7

In the light of many recent reports relating to concentrated DDT sprays (10 to 20 per cent) used to obtain effective residues, it appears that a 0.4 per cent spray, i. e., three pounds per 100 gallons, should leave an entirely ineffective residue. However, the residue obtained was quite effective. One gallon of spray thoroughly covered the trunks of 60 trees, and it is estimated that with the type of nozzle used at least half the spray missed the trunk or ran off. It is estimated that a maximum DDT residue of 450 mg./sq. ft. of trunk surface was deposited and, if the spray loss were much greater, there would still remain a deposit that is known to be lethal for long periods to insects susceptible to DDT poisoning. The fact that both adults and larvae readily succumb to contact with DDT spray deposit was demonstrated in the laboratory.

At the time of these spray applications the weather was favorable for spraying, and no leaf injury was observed here at any time. But,

[1] The Burr Nurseries, Inc., of Manchester, Conn., supplied trees for all tests and assisted with labor.

when another new planting was treated two days later with the same mixtures (except for the addition of a wetting agent), the temperature was 90° F., it was very dry, and a brisk wind blew droplets on many of the leaves. Here, a considerable amount of foliage injury resulted, appearing first as reddish-purple, circular areas which finally turned black, and many leaves dropped.

In these later trials no infestation occurred in any of the plants, although seedling peaches 50 yards away were well infested. It is believed that the controls were too close to the treated plants and that most of the moths which may have approached to deposit eggs were affected by contact with sprayed plants.

The addition of a wetting agent (Nacconal N. R.) at the rate of 2.5 per cent of the DDT solvent by weight greatly improved the wetting properties of the spray and did not cause foaming nor appreciably increase in run-off.

Soil Fumigant Treatments

For the soil treatments, a liquid was preferred because of relative ease of application. Standard ethylene dichloride emulsion and a proprietary paradichlorobenzene emulsion[1] were used. A knapsack sprayer with the nozzle removed served to distribute the material uniformly after a little practice. The operator moved at a constant speed and the dosage was doubled by doubling the number of applications. The liquid was directed at the soil about two inches from the row. The soil temperature was 64° and the air temperature 72° F. Two days previous there had been 1.5 inches of rainfall and a high wind had moved all the trees so that there was a hollow in the soil at the base of the stems. Moreover, the last cultivation had left a ridge eight inches wide and one inch high near the plants. In most cases the spray hit the tree base and the cup-like depression was filled with liquid that was only slowly absorbed into the wet soil. Four hours after treatment 1.0 inch of additional rain fell. These unfavorable conditions provided a rigid test for the treatments.

These results indicate that mounding the trees after treatment with the emulsions did not affect the kill of borers. Injury to tree tissue was considerably less where the trees were mounded. This was probably due to more rapid absorption of the liquid and would not ordinarily be necessary. Ethylene dichloride and paradichlorobenzene emulsions at standard dosages were about equal in borer-killing effectiveness. "Per cent injury" refers to the per cent of the tissue at the base of the trees which was killed by treatment. "0-20" indicates that some of the plants were unaffected while others sustained light to moderate injury of the bark at the base. Injury was, of course, more severe where the bark had been broken. These two-year peach trees were severely injured by ethylene dichloride application, where-

[1] Para-Scalecide.

TABLE 38. PARADICHLOROBENZENE EMULSION TREATMENTS FOR PEACH TREE BORER

Test conditions: Not mounded
Each test constitutes 3 replicates of 8 two-year trees

Dosage	Total trees	Number infested	Per cent infested trees freed	Per cent total trees remaining infested	Total borers	Per cent borers killed	Per cent tree injury
2 oz. 1–15	24	5	80	4.2	5	80	0–10
4 oz. 1-15	24	4	100	0	4	100	0–10
2 oz. 1-7	24	5	100	0	6	100	0–10
4 oz. 1-7	24	5	80	4.2	5	80	0–10
8 oz. 1-7	24	6	50	12.5	6	50	0–10
Control	24	7	14	25	7	14	0
Total	144	32 (22%)			33		

TABLE 39. PARADICHLOROBENZENE EMULSION TREATMENTS FOR PEACH TREE BORER

Test conditions: Trees mounded
Each test constitutes 5 replicates of 8 two-year trees

Dosage	Total trees	Number infested	Per cent infested trees freed	Per cent total trees remaining infested	Total borers	Per cent borers killed	Per cent tree injury
2 oz. 1-15	40	9	66	7.5	9	66	0
4 oz. 1-15	40	8	87	2.5	8	87	0
2 oz. 1-7	40	6	100	0	6	100	0
4 oz. 1-7	40	12	58	12.5	12	58	0
8 oz. 1-7	40	5	80	2.5	5	80	0–10
Control	40	8	0	20	8	0	0
Total	240	48 (20%)			48		

TABLE 40. ETHYLENE DICHLORIDE EMULSION TREATMENTS FOR PEACH TREE BORER

Test conditions: Not mounded
Each test constitutes 8 replicates of 8 two-year trees

Dosage	Total trees	Number infested	Per cent infested trees freed	Per cent total trees remaining infested	Total borers	Per cent borers killed	Per cent tree injury
2 oz. 7.5%	64	14	71	6	16	75	0–80
4 oz. 7.5%	..	..	..	..	..	..	....
2 oz. 15%	64	8	100	0	8	100	0–100
4 oz. 15%	64	7	100	0	7	100	0–100
Control	64	9	22	11	9	22	None
Total	256	38 (15%)			40		

as paradichlorobenzene caused no or inconsequential injury at the highest dosages used.

Although no borer infestation was observed, similar treatments were applied to trees in sample plots of a nearby block of one-year seedling peaches, for the purpose of determining plant tolerance.

TABLE 41. ETHYLENE DICHLORIDE EMULSION TREATMENTS FOR PEACH TREE BORER

Test conditions: Trees mounded
Each test constitutes 5 replicates of 8 two-year trees

Dosage	Total trees	Number infested	Per cent infested trees freed	Per cent total trees remaining infested	Total borers	Per cent borers killed	Per cent tree injury
2 oz. 7.5%	40	11	54	10	14	50	0
4 oz. 7.5%	40	7	86	2.5	7	86	0
2 oz. 15%	40	8	87	2.5	8	87	0–20
4 oz. 15%	40	7	71	5	7	71	0–100
Control	40	11	0	27.5	11	0	0
Total	200	44 (22%)			47		

TABLE 42. CHEMICAL INJURY TO ONE-YEAR PEACH SEEDLINGS

8 replicates of 8 trees each

Paradichlorobenzene emulsion	
2 oz. 1 – 15	No injury
4 oz. 1 – 15	No injury
2 oz. 1 – 7	No injury
4 oz. 1 – 7	Slight brown flecking in cortex, inconsequential
8 oz. 1 – 7	Slight brown flecking in cortex, inconsequential; Does not appear more extensive than 4 oz. dosage
Ethylene dichloride emulsion	
2 oz. 7.5%	Moderate to severe with some killed roots
4 oz. 7.5%	Severe to dead
2 oz. 15%	All roots dead

Soil conditions and depressions at the tree bases were similar to those described above. All of these trees were mounded three hours after treatment and injury was much more severe than for the two-year trees.

It is apparent that under these conditions ethylene dichloride is unsafe to use on one-year peach trees at a concentration sufficient to give effective peach tree borer control. Paradichlorobenzene emulsion caused only minor injury at the higher dosages.

Discussion

Although this is not a large-scale experiment and is somewhat preliminary in nature, the results attained with DDT emulsions are very promising. A 0.4 per cent emulsion gave excellent control. Whether or not the addition of bentonite improves the mixture remains to be proven. The timing of the application should be more definitely established. There is also the question of possible injury to the trees by the DDT.

The results attained with paradichlorobenzene and ethylene dichloride are not so clear-cut and are subject to the same criticisms as above. Moreover, the latter apparently causes severe injury to young peach trees under some conditions. Neither of these two materials should be condemned on the basis of these experiments alone.

THE CONTROL OF COMSTOCK'S MEALYBUG (*Pseudococcus comstocki* Kuwana) ON TAXUS IN CONNECTICUT

PHILIP P. WALLACE[1]

Comstock's mealybug has been known for several years to occur occasionally on *Taxus* spp. throughout Connecticut, but in the fall of 1944 two serious infestations were observed. Mealybugs were very abundant on large commercial nursery plantings where their feeding had caused loss of foliage and stunting of growth.

The dwarf, close-growing, short-leaved varieties of *Taxus cuspidata* were generally the most seriously affected, although many closely-sheared specimens of *capitata*, *media*, and *hicksi* varieties were also found heavily infested.

Usually the first indications of injury to the plants are yellowing and dropping of leaves. Growth is greatly diminished and, as occasional twigs die, the plant presents a thinned and sickly appearance. If the infestation is unchecked, plants may become worthless and finally die. This decline is aggravated by unfavorable growing conditions.

Comstock's mealybug hibernates here only in the egg stage, and during the winter and early spring the small, oval, orange-red eggs are found in grayish wax masses in the axils of the twigs and leaves, particularly toward the inside of the plant where they are well protected. The young crawlers emerge in the spring after about two weeks of warm weather, very shortly after new growth has started, and commence feeding at the base of the old needles and on one- and two-year twigs. As the mealybugs develop, they migrate over the entire plant, feeding on both new and old leaves and shoots. There are several, two to three, overlapping generations a year and, with the exception of early spring, all stages are found throughout the growing season.

Control

Chemical control is a problem of contacting and wetting the insect and its eggs within the waxy masses with a material which will not injure the foliage. The insect itself or the eggs are rather easily killed by most of the common contact insecticides, if the waxy covering is dissolved or penetrated so that they are actually wetted.

For preliminary tests, twigs containing egg masses and adults were brought into the laboratory and dipped for five seconds in the various insecticide mixtures, and any composition which did not cause a high kill under these conditions was eliminated.

Forty per cent nicotine sulfate at the rate of one pint per 50 gallons of water, plus soap at the rate of six pounds per 100 gallons, caused practically no kill. At one quart to 50 gallons, the kill was only 60 per cent.

[1] See footnote 1, page 33.

DDT at the concentrations of 0.5, 1.0, and 2.0 per cent applied to potted yew plants as a water suspension, and in oil-water emulsion, with an effective wetting agent, Nacconal N. R.[1] at the rate of 4.0 ounces per 100 gallons did not cause an appreciable kill of mealybugs. Three to five days after treatment many mealybugs were exceptionally active and were observed crawling away from the treated plants, but only a few were found dead. Two weeks later all stages were abundant on the plants treated with DDT, and there appeared to be no significant reduction in the mealybug population. DDT in vapor form was likewise ineffective. But hymenopterous parasites of the mealybug which had been abundant were eliminated by these treatments.

Lethane 440 diluted by volume, 1-300 water, killed 88 per cent of the adults and eggs. The survivors were protected by dirt and heavy wax. At the dilutions of 1-600 and 1-1200, wetting and penetration were insufficient.

Kerosene emulsion (Ultrasene, specific gravity .76) at 1.5 per cent gave a fair kill of exposed individuals but a poor kill within the masses. At 3 per cent concentration, 80 per cent were killed and, at 6 per cent, the kill was complete.

Lime sulfur. Wetting and penetration of lime sulfur mixtures under accumulations of clay and into waxy masses were improved also by the addition of the wetting agent, Nacconal N. R., at the rate of four ounces per 100 gallons. This was used for all tests with lime sulfur. At a dilution by volume of one part liquid lime sulfur to 39 parts water, a few eggs and crawlers escaped in the thickest masses, giving a kill of approximately 85 per cent. At 1-19, 1-13.3 and 1-9, the kill was complete in every test.

From these trials it was apparent that lime sulfur and kerosene emulsion were the most effective materials tested. However, kerosene emulsion and other similar petroleum oils can seldom be safely used on yews because of the danger of foliage injury.

When liquid lime sulfur at one to nine parts water was applied to heavily infested, large, potted yews in the greenhouse, the newly started growth was killed back and slight injury occurred to older foliage. In addition, the plants receiving this treatment failed to "come back" properly that season even though the mealybug infestation was completely eliminated. Plants sprayed with a 1-19 dilution received slight injury to the new growth but recovered quickly and the kill of mealybugs in all stages was complete. At 1-39 there was some survival of both eggs and bugs.

It should be recognized that lime sulfur, at any of the dilutions tested, leaves a grayish residue on the foliage which persists for about

[1] Supplied by the Naugatuck Chemical Company through the courtesy of Dr. T. W. Kerr.
Nacconol N. R. is an alkyl aryl sulfonate (not a sulfated fatty alcohol).

two months, so infested plants which are to be sold in the spring should be treated the previous fall. These tests further suggest that foliage injury can be avoided by treating when the plants are dormant and at a time when the temperature will not fall below 32° F. for 24 hours.

Determination of the advisability of treatment will rest largely with the grower. A heavy infestation may cause serious loss by inhibiting growth, particularly with the dwarf varieties. If the entire plant receives approved fumigation before shipment, the mealybugs will undoubtedly be killed but, if the grower is particular about the appearance of the plants, fumigation at the time of shipment would not be completely satisfactory because the dead bugs and wax masses remain on the plant for a considerable time. It is believed that a late fall application of liquid lime sulfur at one part to 19 parts water will generally be the most satisfactory treatment.

Summary

Comstock's mealybug is widely distributed on *Taxus* spp. in Connecticut and has recently become a serious pest in certain nursery plantings. Hibernation occurs in the egg stage and the crawlers emerge after about two weeks of warm weather in the spring. There are two to three generations per year.

Several insecticides were tested and liquid lime sulfur at 1-19 with a wetting agent, applied while the plants were dormant, was a satisfactory and highly effective treatment.

USE OF DDT DUSTS TO CONTROL WEEVILS ON SEEDS

NEELY TURNER

The efficacy of lime as an insecticide to control weevils on peas was discovered by Metcalf (1917) after a series of treatments with dosages ranging from four parts of lime to one part of seed (by weight) to one of lime and 11 of seed. He suggested the use of at least one part of lime and two parts of seed. Mackie (1925) found that copper carbonate used at the rate of two ounces to a bushel of wheat seed effectively controlled rice and grain weevils, various species of grain beetles and the Angoumois grain moth.

Zacher (1929) confirmed the action of copper carbonate and investigated and reported that copper salts acted in inverse ratio to their solubility. Finely divided copper was not toxic. Oxides and carbonates of magnesium and zinc were found to be toxic. Zacher and Kunike (1930) found that alkalinity was not involved, because finely ground compounds of silicon were also effective. The materials acted to cause a loss of weight of the treated insects, probably because of loss of water. In damp air the dusts were not effective.

Chiu (1939a) determined the effect of particle size of crystalline silica on toxicity. The time required to kill a given percentage of bean weevils was less as the particle size was decreased. He also measured the differences between materials and found that crystalline silica was much more toxic than amorphous silica. He confirmed this work (Chiu, 1939) on rice and granary weevils, and also showed that increase in relative humidity decreased toxicity.

Jenkins (1940) and Fitzgerald (1944) in Australia studied several materials for protection of grain. Briscoe (1943) in England investigated the method and found suitable materials for protecting grain. Particle size was important; the maximum effectiveness seemed to be between one and two micra. Rough particles were more effective than smoothly rounded ones of the same particle size. The findings of Parkin (1944) were substantially the same as those of Briscoe. Parkin offered the hypothesis that the hard particles of dust interfered with the continuity of the water-retaining lipoid layer of the cuticle.

Cotton and Frankenfeld (1945) suggested the use of either magnesium oxide, one ounce to a bushel of seed, or 3 per cent DDT dust at one-half ounce to a bushel. Farrar (1945) reported complete control of grain pests following use of one ounce 5 per cent DDT dust to a bushel of grain. Packard (1945) reported that wheat was protected by .05 per cent by weight of 3 per cent DDT dust, or about one-half ounce per bushel.

Experimental. The effect of DDT dusts on adults of the bean weevil was studied in the laboratory in November, 1944. Preliminary tests showed that as little as .0625 per cent by weight of 4 per cent DDT dust (approximately .025 ounce DDT per bushel of seed) killed all the adult bean weevils on treated seed within three days. Use of a .5 per cent DDT dust showed that as little as .125 per cent by weight of seed killed all the weevils within four days. It was noticed that much of the dust used in treating the 100 gram samples stuck to the sides of the glass bottle. Tests were therefore made on the beans removed from the treating jars. The results of three replicate tests using 25 weevils in each test were as follows:

	Effect on bean weevils—3 days		
Amount ½ per cent DDT dust	No. dead	No. alive	Per cent dead
.5 g. – 100 g. seed	70	5	93.3
.25 g. – 100 g. seed	69	6	92.0
.125 g. – 100 g. seed	60	15	80.0
.0625 g. – 100 g. seed	43	32	57.3
None	5	70	6.7

A test of coverage was made by applying 1 per cent, 2 per cent and 4 per cent DDT dusts to bean seed at four dosages. Four tests were made by adding 25 bean weevils to each sample, and determining mortality after three days. The results were as follows, with all percentages based on 100 weevils in four replicates:

1 Per Cent Dust		2 Per Cent Dust		4 Per Cent Dust	
Dosage	Per cent dead	Dosage	Per cent dead	Dosage	Per cent dead
.25 g./100 g. seed	78	.125 g./100 g. seed	78	.0625 g./100 g. seed	82
.125 " "	72	.0625 " "	72	.0313 " "	77
.0625 " "	65	.0313 " "	62	.016 " "	61
.0313 " "	45	.016 " "	35	.008 " "	44

These results indicate that within the limits of this experiment it made little difference whether a given amount of DDT was applied as 1, 2, or 4 per cent dust. The amount of dust required for a high degree of control was relatively low. It was, however, about the same quantity as Jenkins (1940) reported was necessary to control stored grain pests when calcined diatomaceous earth was used.

Literature Cited

Briscoe, H. V. A., 1943. Some new properties of inorganic dusts. J. R. Soc. Arts *91*:593-607, (Rev. Appl. Ent. 32).

Chiu, S. F., 1939a. Toxicity studies of so-called "inert" materials with the bean weevil, *Acanthoscelides obtectus* Say. Jour. Econ. Ent. *32*: 240-248.

Chiu, S. F., 1939b. Toxicity studies of so-called "inert" materials with the rice weevil and the granary weevil. Jour. Econ. Ent. *32*:810-821.

Cotton, R. T., and J. C. Frankenfeld, 1945. Protecting stored seed from insect attack. U. S. D. A. Bur. Ent. and Pl. Quar. E 677.

Farrar, M. D., 1945. Experiments with DDT conducted by Experiment Stations, Agricultural Colleges, and other non-federal research organizations. Illinois Nat. Hist. Survey, Urbana, Ill., U. S. D. A. Bur. Ent. and Pl. Quar. E 644p.

Fitzgerald, J. S., 1944. The effectiveness of various mineral dusts for the control of grain pests. Australia Council for Sci. and Ind. Res. Bul. 182.

Jenkins, C. F. H., 1940. Notes on control of weevils in wheat. Jour. Dept. Agr. W. Aust. (2) No. 4. 411-417. (Rev. Appl. Ent. 29).

Mackie, W. W., 1925. Prevention of insect attack on stored grain. Calif. Agr. Expt. Sta. Circ. 282.

Metcalf, Z. P., 1917. Lime as an insecticide. Jour. Econ. Ent. *10*:74-78.

Packard, C. M., 1945. Experiments with DDT for control of insects attacking cereal and forage crops in the field and in storage. U. S. D. A. Bur. Ent. and Pl. Quar. E 640.

Parkin, E. A., 1944. Control of the granary weevil with finely divided mineral dusts. Ann. Appl. Biol. *31*:84-88.

Zacher, F., 1929. Ein neues wirksames Mittel gegen Kornkäfer und andere Vorratsschadlinge. Nachrbl. Deut. Pfl. Sch. Dienst *9*:67-68. (Rev. Appl. Ent. *17*:641-642).

Zacher, F., and Kunike, G., 1930. Beitrage zur Kenntnis die Vorratsschadlinge. 5 Beitrag. Untersuchungen uber die insektizide Wirkung von Oxyden und Karbonaten. Arbeit aus der Biol. Reichsanstalt f. Land u. Forstwirts. *18*:201-231. (Rev. Appl. Ent. *18*:664).

SEED TREATMENTS TO CONTROL SEED CORN MAGGOTS

Neely Turner

The high toxicity of DDT to the larvae of flies (Simmons and Wright, 1944) suggested its use to control the seed corn maggot. Lima beans were treated with 3 per cent DDT, *Spergon* (Chloranil), and both *Spergon* and DDT. The treated seed and an untreated check were planted 10 seeds in a plot, randomized in each of four blocks. Plantings were made at weekly intervals starting May 7, 1945. The weather was cold and wet, and none of the seeds germinated. Subsequent plantings made May 15 and 22 were heavily infested by seed corn maggots, and were examined June 15. A summary of the results is given in Table 43. The concentration of the treatment is by weight of seed.

Table 43. Effect of Seed Treatment on Seed Corn Maggot

Material	Conc.	Number of seed: Sprouted	Number of seed: Normal plants	Total infested[1]
		Planted May 15		
Spergon	1.0%	24	17	36
	.5	14	8	28
	.25	21	14	36
	.125	10	6	31
DDT (3% Dust)	1.0%	4	1	26
	.5	10	7	30
	.25	3	1	25
	.125	9	5	29
Both DDT and Spergon	1.0%	19	13	35
	.5	19	14	31
	.25	16	10	28
	.125	15	10	30
Check	...	5	3	28
		Planted May 22		
Spergon	1.0%	20	18	37
	.5	23	19	31
	.25	24	19	39
	.125	17	15	34
DDT	1.0%	3	3	31
	.5	5	4	33
	.25	8	7	36
	.125	6	5	26
Both DDT and Spergon	1.0%	16	14	38
	.5	19	15	36
	.25	19	16	37
	.125	7	5	28
Check	...	7	6	29

[1] Including seeds that did not germinate.

There was no marked reduction in the infestation of seed corn maggots following any of the treatments. The low figure for infestation of the untreated checks is probably not a true estimate of the infestation. A great many of the seeds rotted and could not be found when the examination was made.

The largest number of normal plants was produced by treatment with *Spergon*. When DDT was added, there was no evidence of control of the seed corn maggot. The DDT apparently affected *Spergon*, however, as evidenced by the lower number sprouted and by the smaller number of normal plants, particularly in the May 22 planting. It is possible that the concentration of DDT was too low for effective control of this pest. However, Simmons and Wright used as little as 0.1 per cent DDT in emulsions with good results.

Literature Cited

SIMMONS, S. W., AND WRIGHT, M., 1944. The use of DDT in the treatment of manure for fly control. Jour. Econ. Ent. *37*:135.

WIREWORMS ON POTATOES

D. E. GREENWOOD

Wireworm control investigations during 1945 continued along the lines of previous years. Practically all of the work was carried on either in the greenhouse during the winter months or the field laboratory during the growing season.

D-D Mixture[1]

Field applications in May, 1945, using 600 gallons of dilute emulsion (400 pounds crude D-D Mixture) per acre were unsuccessful even though wireworms were actively feeding on rye roots at the one-inch level. The early part of the 1945 season was unusually wet and the general belief is that D-D Mixture is more effective in dry soils than in wet soils. The material not only had no lethal effect under these conditions but even failed to deter the wireworms from their feeding activities.

DDT

Adults. It was reported in 1944 that 3 per cent DDT dust[2], applied to the soil surface, was effective against the adults of the eastern field wireworm and that field tests were to be run in 1945. Because of the unusually rainy weather during flight period, there was little beetle activity and the dusts were washed in as soon as they were applied. The results of a limited number of field trials substantiate the laboratory evidence reported last year. In general, 50 pounds of a 3 per cent dust per acre could be expected to be effective, but only under ideal conditions. If the flight period were drawn out over three or four weeks, or if more than occasional showers were expected, 100 or even 200 pounds of dust per acre would be necessary. One apparent disadvantage to such a control practice is that the flight period comes at a time when most fields are under cultivation in one form or another.

[1] Dichloropropane-dichloropropylene.
[2] Gesarol A.

Larvae. Results from the 1944 field and laboratory work suggested that soil treatments with DDT left much to be desired for wireworm control and that, if DDT were to be used successfully against the larvae, other methods of application would have to be employed. Accordingly, laboratory tests were made early in the 1945 season in which the larvae were brought in contact with surfaces sprayed with a concentrated DDT preparation and on which a heavy deposit of DDT was visible. The inconsistency and uncertainty of the results of these tests led to the incorporation of DDT in baits. This method of using DDT proved satisfactory in the laboratory under certain conditions and will be tried in the field in 1946.

Contact Treatments

Generally speaking, all contact treatments produced some mortality but only of a very low order. The most pronounced effect of treatment was the inability of the larvae to feed to any degree as compared with larvae in the controls. Even this effect soon wore off, but feeding appears to be a very uncertain criterion upon which to base a comparison. The results obtained when larvae were placed in pots with sprayed potato seedpieces were of such a nature that this method of applying DDT cannot be abandoned yet. Most of the mortality was attributable to cannibalism, which in turn might have been the result of a pronounced hypersensitivity induced by coming in contact with the DDT deposit on the seedpiece. This hypersensitivity was not observed in other contact treatments.

DDT Baits

The most successful method of using DDT for wireworm control was that in which the DDT was added to a bait to which the larvae would readily come to feed (in the absence of other food). Only a few materials were tested since the method of control, and not the materials, was the principal point of interest. Ground wheat cereal proved readily acceptable as food to the wireworms and did not give off strong ammonia fumes upon decomposition as did cottonseed and soybean meal. Because of the small amounts of DDT desired (large doses were repellent), it was added as a 3 per cent dust to the dry cereal and the whole mixture moistened with water. The individual baits were about an inch and a half in diameter and were placed in containers of soil before introducing the larvae. Approximately 300 larvae were used in the tests.

The amount of actual DDT per pound of dry bait varied during the course of the work but in the majority of cases it did not exceed one-quarter to one-half gram. Lower dosages were not attempted because it was felt that the amounts were already small enough to be certain of proper distribution throughout the bait.

NOTES ON THE FEEDING OF WIREWORMS

R. L. Beard

In potato fields heavily infested with wireworms, a period of intense feeding activity of the wireworms is usually to be observed soon after the time of planting. The feeding activity then appears to subside until later in the summer when the potato tubers are of some size, at which time feeding activity is accelerated again. With a view to elucidating some of the feeding habits of wireworms, observations were made on the feeding and molting activities under laboratory conditions.

The Feeding Pattern of Wireworms Relative to Temperature and Molting

Some 120 wireworms were incubated in individual vials or jars, half of them being kept at a temperature of 75° F. and the rest at a temperature of 85°. Half of each group was fed potatoes, and the remainder was fed sprouting wheat, fresh food being given at the time of each observation. The wireworms were examined approximately twice weekly, feeding activity was noted and molting, as evidenced by cast skins, was recorded.

Fourteen wireworms failed to molt during the course of the experiment. There was nothing distinctive about the feeding pattern of these individuals, and there were no apparent differences associated with temperature.

From the observations on the feeding activities of the other wireworms, which did molt, no definite conclusions can be drawn. The feeding pattern seemed almost entirely a random one, affected neither by the temperature nor food differences used in this test. There was a definite tendency, though not invariable, for a period of fasting to precede a molt, and there was a suggestion of a tendency for a period of feeding to follow shortly after the time of molting. This was not consistent enough, however, to explain much of the mass feeding pattern observed in the field.

Growth, Molting and Mortality as Affected by Feeding Conditions

The effect of feeding conditions on growth and mortality was observed by incubating wireworms in soils containing different quantities of available food. In all cases Windsor soil was used, but one portion was ignited to remove the organic matter. In another portion the organic matter was increased by the addition of liberal quantities of leaf mold. Another portion was left unaltered. A fourth portion was left unaltered but wheat grains were added to provide food for the wireworms.

In one series of observations, utilizing 40 individuals, wireworms were incubated under the four feeding conditions described and individually weighed at intervals of about twice weekly to determine if changes in body weight would indicate the utilization of organic matter in the absence of growing plant food.

It was only among those wireworms which were provided with wheat grains that there was an increase in body weight. Among those living in ignited soil there was a progressive decrease in body weight. There was also some loss, though less noticeable, among those wireworms incubated in unaltered soil and in that fortified with organic matter. Between the last two groups there was no appreciable difference.

On the basis of this single experiment which was not replicated nor repeated, it appeared that wireworms require growing plants for food if they are to gain in weight, and it is doubtful if organic matter present in the soil is utilized to any appreciable extent in maintaining metabolism.

In this and in another series incubated under similar conditions, the molting trends were observed. During the course of the observations, some wireworms molted as many as three times, but the majority molted only once. In all groups there was at least some tendency for a high frequency of molting during the early period of observation after the wireworm had been removed from cold storage. There were also subsequent periods of high frequency in the various groups, but no pattern was apparent which could be associated definitely with feeding activity. Even those individuals maintained in the absence of organic matter molted as freely as those in the other groups.

Among the groups of wireworms incubated under different feeding conditions, mortality trends showed some aberrancies, but these did not seem to be associated with the presence or absence of food. For example, in one series, the group reared in ignited soil exhibited lower mortality than other groups. On the other hand, in the second series, one of the groups provided with sprouting wheat showed much higher mortality than other similar groups. Due to a mechanical failure of the rearing cabinet, causing the death of all wireworms, the observations were terminated before all the individuals either completed their development or succumbed. Consequently, the observed mortality trends were for a period of only about three months.

A STUDY OF THE RELATIONSHIP BETWEEN ORGAN AND ORGANIC ENVIRONMENT IN THE POST EMBRYONIC DEVELOPMENT OF THE YELLOW FEVER MOSQUITO

Aedes Aegypti

DIETRICH BODENSTEIN[1]

The characteristic sequence of events exhibited by a developing organ is the result of a closely coordinated interplay of action and reaction between the organ itself and its organic environment. For an understanding of the causal factors in development, it becomes necessary to know which part of the chain of developmental events is played by the organ and which by the organic environment.

In the present investigation, this problem was attacked experimentally by transplanting identical organs into different environments. These transplants were then compared as to their developmental behavior. The results thus obtained allow conclusions to be drawn as to the nature of the environmental forces acting upon the organ, while the observed responses of the organ bring to light some of its developmental potencies.

Material and Methods

The yellow fever mosquito, *Aedes aegypti*, was used for this study. This mosquito is easily reared in the laboratory. The females need a blood meal before the eggs develop and are laid. Since only a relatively small number of mosquitoes was needed for this investigation, they were fed with human blood. The larvae were reared from eggs which were held in cold storage on moist filter paper until needed. For hatching, the desired number of eggs was submerged in tap water which included some food. The larvae usually emerged within two to four hours. They were reared in tap water and fed on powdered dog food. Within about five days at 28° C., the larvae reached maturity and pupated. The pupae hatched two days later. The adults to be operated upon were kept in glass vials closed with cotton gauze stoppers. They were fed on sugar water; for this, a cotton ball saturated with sugar water was placed at the bottom of the vial.

The transplantations were made with the same injection apparatus used in transplantation experiments on *Drosophila* (Beadle and Ephrussi, 1936). Only adults were anesthetized with ether for the operation, the pupae and larvae being placed on moist cotton without anesthesia. The animal was held in place on this cotton operating table by a few fibers of cotton which were drawn over it. The tissues used for the transplantations were dissected in insect Ringer (one liter distilled water, NaCl 7.5 gr., KCl 0.35 gr., $CaCl_2$ 0.21 gr.) and injected into the abdominal cavity of the host where they floated loosely in the body fluid of the animal. Both pupae of all ages and adults are

[1] Formerly Connecticut State Board of Mosquito Control; now Medical Research Laboratories, Edgewood Arsenal, Edgewood, Md.

relatively easy to inject and withstand the operation quite well. The larval operations, however, are much more difficult, since the puncture of the body wall by the injection needle is always followed by the loss of a great amount of blood. This weakens the animal to such an extent that it is unable to hold itself to the surface of the water, and usually sinks to the bottom of the culture dish, where it suffocates before it regains its strength. If the transplanted tissue is small, a finer bore injection needle can be used and the rate of mortality is much lower.

For histological studies the animals were fixed in alcoholic Bouin (hot), embedded over methyl benzoate in paraffin and sectioned at 10 microns. The sections were stained with Delafield's hematoxylin and counterstained with Orange G. Total mounts were prepared in many instances; these were stained with orcein and mounted in diaphane.

Experimental Part

Transplantation of Malpighian Tubes

This group of experiments was designed to test the growth capacity of very young larval organs in different organic environments. The tissues used were Malpighian tubes. These organs were taken from completely developed larvae dissected out of stored eggs. Parts of the intestinal tract were usually left attached to the Malpighian tubes at dissection. These transplants were then put into the desired environment. These egg larvae were used as donors in order to obtain material uniform in age.

To provide a basis for comparing the degree of development reached by the transplanted tubes with that of normal development, a series of normal developmental stages was prepared, as shown in Figure 17. Figure 17-a shows a Malpighian tube of an egg larva and thus represents the transplant at the time of transplantation. Figure 17-b is a tube of a 1st, Figure 17-c of a 2nd, Figure 17-d one of a young 4th and Figure 17-e one of an old 4th instar larva. By adding the signs + or – before the letter signifying each stage, one can indicate that development is a little more or less advanced than shown in the figure. In doing this, the staging becomes quite accurate and allows the recording of even small size differences.

The experiments are composed of three separate series, as follows: (1) Malpighian tubes transplanted into adult mosquitoes, (2) Malpighian tubes transplanted into young pupae, (3) Malpighian tubes left in their larval environment and the young larvae then grown for the desired length of time. In all cases save four (See Table 44), the transplants were allowed to develop for two days in their respective environments. They were then dissected out, stained, mounted and compared with the normal developmental series and with each other.

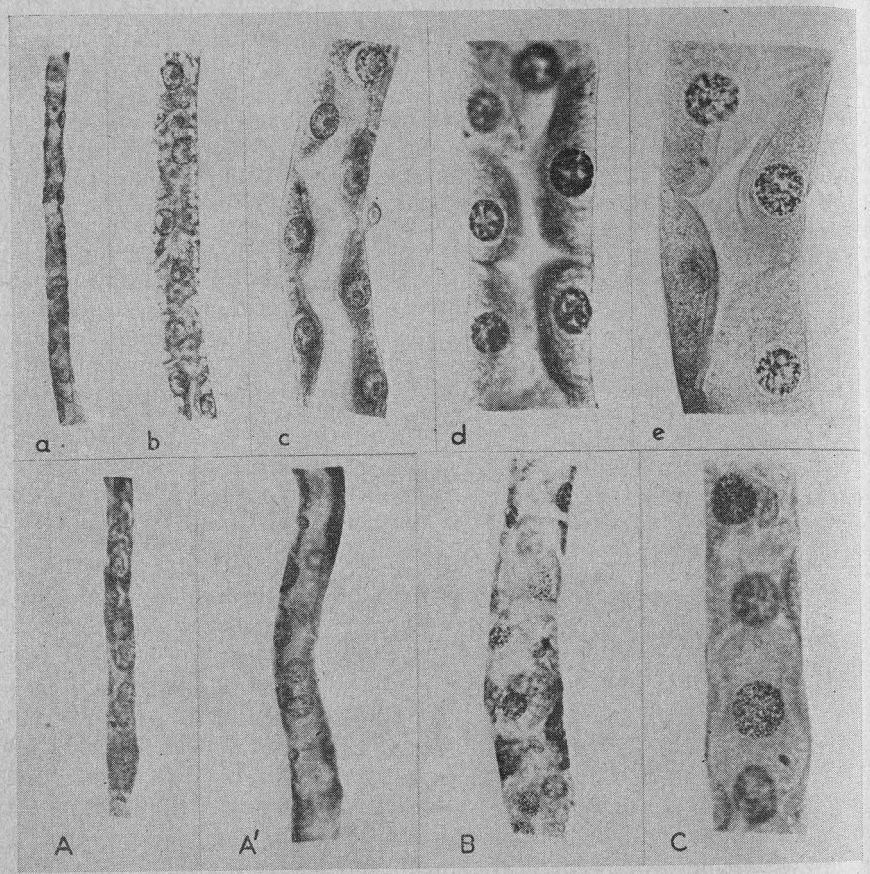


Figure 17 a - e. Normal development of larval Malpighian tubes.

a. Malpighian tube of egg larva.
b. Malpighian tube of 1st instar larva.
c. Malpighian tube of 2nd instar larva.
d. Malpighian tube of young 4th instar larva.
e. Malpighian tube of old 4th instar larva.
A. Malpighian tube of egg larva cultured for 2 days in the abdomen of an adult fly.
A'. Malpighian tube of egg larva cultured for 5 days in the abdomen of an adult fly.
B. Malpighian tube of egg larva cultured for 2 days in the abdomen of a pupa.
C. Malpighian tube of a two-day-old larva.

Table 47 summarizes the results of these experiments. They show that the transplanted tissue grows in all three environments. The best growth is exhibited by Malpighian tubes in their own larval environment. The pupal environment still promotes considerable growth, while the least growth takes place in the adult host. Figure 17-A, B, C illustrates the situation clearly, showing the different de-

TABLE 44. TRANSPLANTATION OF MALPIGHIAN TUBES FROM EGG LARVAE

Environment	Days transplant remains in host	Stage of development reached
Larva	2	d
"	2	d
"	2	d
"	2	d
"	2	d
"	2	e
"	2	e
"	2	e
"	2	e
"	2	e
"	2	e
Pupa	2	c–
"	2	c–
"	2	c–
"	2	d
"	2	c–
Adult	5	c
"	5	c
"	5	c–
"	4	c–
"	2	b–
"	2	b
"	2	b
"	2	b

grees of development reached by each tube which was cultured in different environments for the same length of time. Although but little growth takes place in the adult environment, growth does not cease after two days, but continues at a slow rate. This is shown by the fact that Malpighian tubes left for five days instead of two days in the adult host are larger than the two-day-old transplants, as can be seen if one compares Figure 17-A with Figure 17-A'.

Incidentally, the same developmental behavior as exhibited by the Malpighian tubes in the three environments tested is followed by the pieces of intestinal tract which were transplanted together with the tubes. These tissues are strictly larval organs and disintegrate during metamorphosis, in contrast to the Malpighian tubes, which maintain their identity during pupal life and are but slightly changed. It is interesting in this connection to note that purely larval organs, such as the larval intestines, are able not only to maintain themselves but also to grow in an imaginal environment. Moreover, the type of growth exhibited by the larval intestine in the adult environment is characteristically similar to that performed by the organ in its own larval environment; that is, there is an increase in cell size.

Transplantation of Imaginal Discs

The donors which furnished the transplants in this second group of experiments were larvae of the last instar instead of young egg

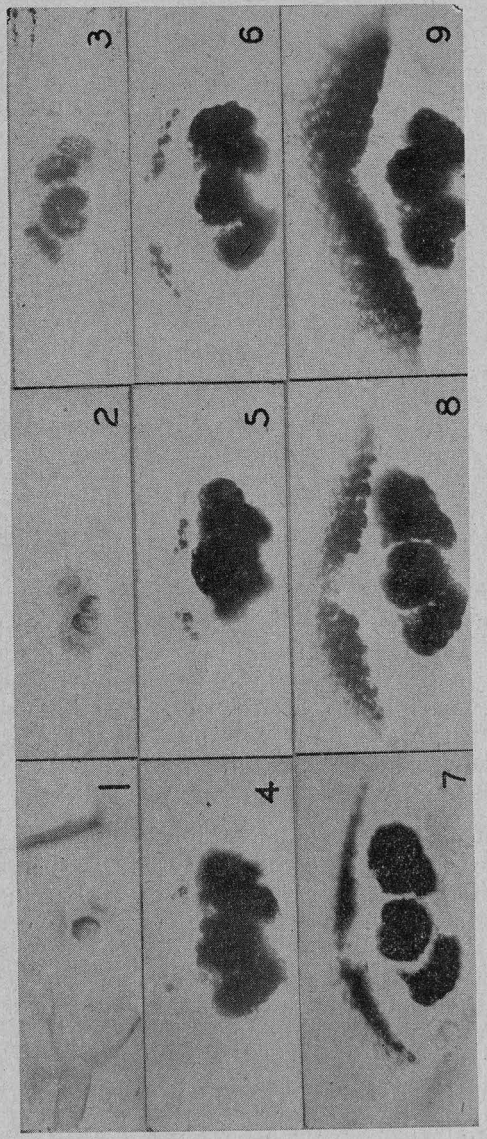


Figure 18. Stages in the development of the larval and imaginal eye during larval life. 1. Larval eye of a 1st instar larva. 2. Larval eye of a 2nd instar larva. 3. Larval eye of a 3rd instar larva. 4 - 9. Larval eyes of successively older last instar larvae. Note the appearance of imaginal eye pigment above the larval eye. Note also the increase of the pigmented area as the larvae become older.

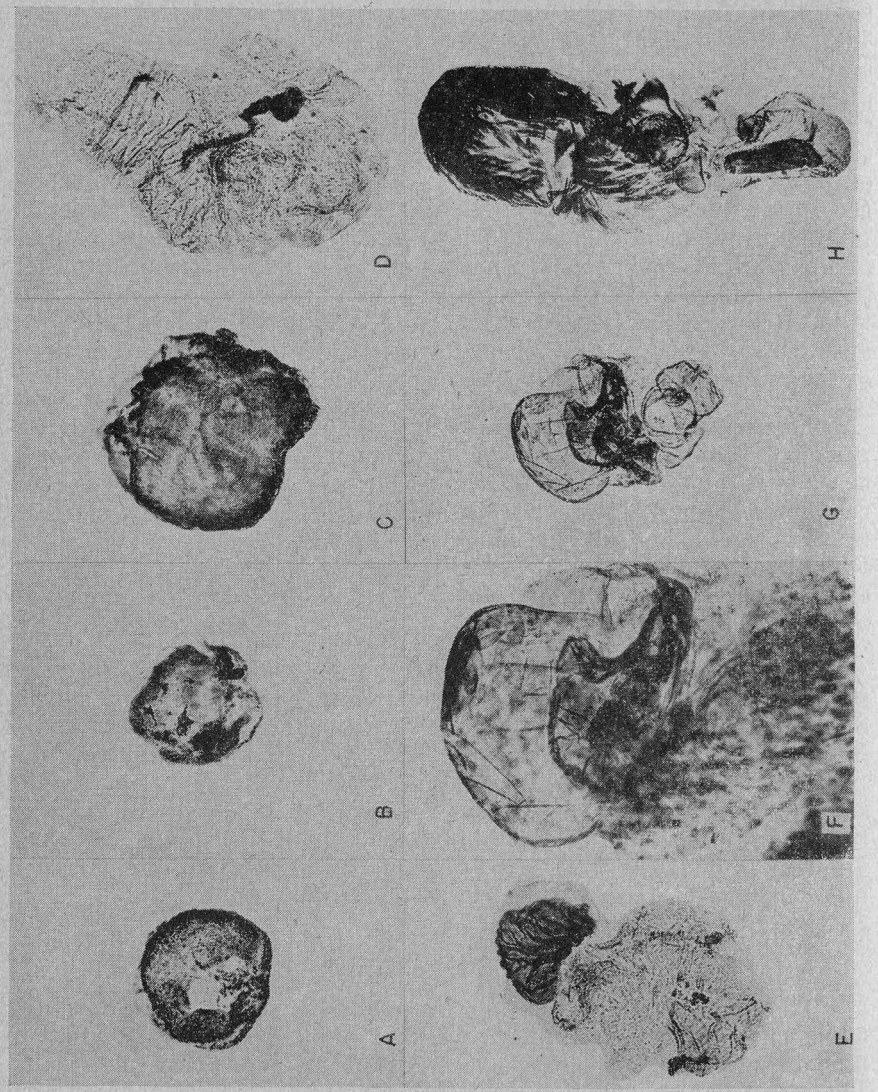
larvae. The organs transplanted were the so-called thoracic discs, which represent the primitive anlagen of the future wings and legs of adult organisms. The anlagen have already undergone their main larval growth prior to the transplantation; this is in contrast to the Malpighian tubes of the previous experiments, which at the time of transplantation had their larval growth period still ahead of them. The imaginal discs, moreover, grow mainly by cell multiplication, and not by cell size as the Malpighian tubes do. During metamorphosis the imaginal anlagen are changed much more drastically than the Malpighian tubes. They are transformed from a rather primitive larval state into the highly specialized structure of an adult leg or wing, as the case may be. Each thoracic disc, whether it may be the future leg, wing or haltere, gives rise not only to the structure implied by its name but also furnishes part of the thoracic hypoderm of the adult insect. Exactly how much each disc contributes toward this goal is not known. Since in the mosquito an active pupal stage is inserted between the larval and adult stage, the thoracic discs are apparently also involved in the formation of the thoracic hypoderm of the pupae, as the following experiments seem to indicate.

To provide material uniform in age for the transplantation experiments, the last instar larvae were staged by using the pigmentation of the imaginal eye as a criterion of age. The imaginal eyes in this species begin differentiation quite early in larval life. By the time the larvae pupate, the imaginal eyes have reached a rather advanced state of differentiation. During the last instar, the imaginal eye structure becomes clearly visible by the formation of pigment in the ommatidia.

Pigment appears first in that part of the imaginal eye nearest to the larval eye. As development proceeds, more and more ommatidia become pigmented and, consequently, the pigmented area becomes larger and larger. At the time of pupation, the imaginal eye pigment forms a wide crescent-shaped area above the larval eye. The amount of pigment present in the imaginal eye at any given time is thus a useful tool for determining the age of last instar larvae. Six different stages of pigmentation (Stages 4-9) have been distinguished following three earlier stages of development. (Figure 18).

Transplantation of Imaginal Discs into Adult Hosts

Thoracic discs of eye stage 7 to 8 were transplanted into the abdomen of adult hosts. The discs were allowed to remain for four to nine days in their new environment. Table 45 summarizes the results. The discs changed but little, whether they remained for four or nine days in the adult host. But in several cases a little growth was observed. No sign of imaginal differentiation, as indicated by sclerotization, could be detected. The general appearance of the discs, as far as size and state of development are concerned, scarcely changed during their stay in the adult host. This is illustrated in Figures 19-A



and 19-B, which show a disc of stage 7 at the time of the operation and a disc of the same age which had been in the adult host for four days.

Transplantation of Imaginal Discs into Pupal Hosts

Imaginal discs of eye stage 7 to 8 were transplanted into the abdomen of very young pupae, where they remained for two days until

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Figure 19-A. Thoracic disc (stage 7) at time of transplantation (stained preparation).

B. Thoracic disc transplanted at stage 7 into the abdomen of an adult host. Four days after the operation (stained preparation). Note: No growth has taken place.

C. Thoracic disc transplanted at stage 7 into the abdomen of a pupal host. Two days after the operation (stained preparation). Note: Increase in size of disc.

D. Thoracic disc (wing) transplanted at stage 7 into the abdomen of a pupal host. Two days after the operation (unstained preparation). Note: Disc has become much larger and is partly sclerotized. Black lines in photo indicate sclerotized areas.

E. Thoracic disc transplanted at stage 7 into the abdomen of larval host of stage 9. Three days after the operation (unstained preparation). Note: Disc is partly sclerotized and has become much larger. Large black portion in the anterior region of the disc shows pupal cuticle, while the darkish structure and lines in the posterior disc region show imaginal cuticle.

F. Anterior portion of transplant shown in Figure 19-G more magnified. Note: Bristles and scales formed by transplant.

G. Thoracic disc transplanted at stage 7 into the abdomen of a larval host of stage 8–. Four and one-half days after the operation (unstained preparation). Note: Transplant is completely differentiated.

H. Thoracic disc (wing) transplanted at stage 7– into the abdomen of a larval host of stage 7. Five days after the operation (unstained preparation). Transplant is completely differentiated. Note the development of typical wing scales.

the hosts emerged. All transplants continued their development in their new environment. As far as size is concerned, the transplanted discs had reached a state of development which corresponds to that reached by a normal disc in its own environment shortly before pupation. At this time in normal development the discs are ready to invaginate in order to form pupal extremities. Thus, the transplants had undergone that part of growth in the pupal environment which they undergo normally during the last stages of larval life.

TABLE 45. TRANSPLANTATION OF THORACIC DISCS INTO ADULT HOSTS

Stage of disc at transplantation	Days transplant remains in host	Condition of disc
7	4	Scarcely changed
7	9	" "
7+	4	" "
7+	4	" "
8–	4	" "
8–	4	" "
8–	4	" "
8–	4	" "
7–	6	" "
7–	6	" "
7–	6	" "
7	6	" "

On turning to consider the state of differentiation reached by the transplants, one finds that this varies greatly. Some of the discs have not differentiated beyond a late last instar stage (eye stage 9) (Figure 19-C), while others show a much more advanced state of differentiation as indicated by the presence of yellowish cuticle (Figure 19-D). This cuticle, an amorphous mass composed of a mixture of lighter and more heavily sclerotized regions, shows no cuticular structures such as bristles, hairs, or scales, and apparently represents the cuticular cover of the pupal organs. The cuticle of the transplanted pieces is yellowish-brown in color in contrast to the cuticle of a normal pupa, which has a more grayish appearance. This light coloration is apparently the result of the beginning but abortive effort of the transplant to sclerotize. The state of differentiation of the transplants would thus be comparable to that of young pupal structures.

Next, attention must be given to the fact that some of the transplants are less differentiated than others, for some had sclerotized, others had not. The main reason for this becomes clear if one looks into Table 46, where the experiments are summarized. One will note that the age of the discs used for transplantation varies. When discs at stage 7– to 7 were transplanted, no sclerotization was observed, while discs transplanted at stage 8– to 8 usually became sclerotized.

The variability in the degree of sclerotization observed is apparently a different matter and reflects differences in the age of the hosts. Although young pupae, from which the flies emerged two days after

the operations, were always used as hosts, their age was not controlled exactly. Age differences of six hours might have existed in the host material. These differences could well account for the variation in the sclerotization of the transplants.

TABLE 46. TRANSPLANTATION OF THORACIC DISCS INTO PUPAL HOSTS

Stage of disc at transplantation	Days transplant in host	Condition of disc
7–	2	Grown, no color
7–	2	Grown, no color
7–	2	Grown, no color
7	2	Grown, no color
7	2	Grown, no color
7	2	Grown, no color
7	2	Grown, no color
7+	1	Grown, no color
8–	2	Grown, some yellowish color
8–	2	Grown, some yellowish color
8–	2	Grown, some yellowish color
8	2	Grown, very light yellow color
8	2	Grown, very light yellow color
8	2	Grown, with dark yellow color

Transplantation of Imaginal Discs into Larval Hosts

Thoracic discs of stage 7– to 7 were transplanted into the abdomen of last instar larvae of different ages. The transplants remained in their respective hosts until they emerged as imagos. Depending on the age of the hosts at the time of transplantation, the transplants remained from three to six days in their hosts. Since all the transplants were dissected shortly after the emergence of the host, and since the pupal period of this mosquito is two days, the transplanted discs remained for different lengths of time in the larval host environment. These time differences are reflected very clearly in the results of the experiments. In general it was found that all discs had developed pupal cuticle. The discs developing in younger hosts had finished their imaginal differentiation completely, while discs developing in older hosts reached much less advanced stages of imaginal differentiation. The experiments are summarized in Table 47 where the individual cases are arranged in two groups, according to their stage of imaginal differentiation. This table shows that when discs of about stage 7 are transplanted into slightly older hosts (about one stage older than the donors) complete imaginal differentiation is obtained. Well formed and fully colored cuticular elements, such as bristles, hairs and scales, are developed by the transplants, which differ in no respect from the identical cuticular structures of the host (Figures 19-E, 19-F, 19-G). The transplanted tissues apparently developed synchronously with the host, since they reached their final

state of imaginal differentiation at the same time as the host. In other words, the discs developed normally in their new environment if they remained for two or more days in the larval host before pupation.

The discs behaved quite differently when they were transplanted into still older hosts, that is, when the time interval between transplantation and pupation of the host was further shortened experimentally. Experiments of this kind are represented in the second group of cases in Table 47. Here, the discs were transplanted into hosts of stage 9 and remained for two or less than two days in their new larval hosts before pupation took place. Imaginal differentiation of these transplants was not complete in this age combination. In some cases where differentiation was more advanced, cuticular structures such as bristles were formed, but the sclerotization was never complete. In other cases, only part of the transplant was slightly sclerotized, while large regions were still transparent and rather immaturely developed. In such discs, no bristles nor hairs were formed (Figure 19-H). The variation in the degree of differentiation within the different cases is undoubtedly due to differences in the age of the host at the time of transplantation.

TABLE 47. TRANSPLANTATION OF THORACIC DISCS INTO LARVAL HOSTS

Stage of disc at transplantation	Stage of host at transplantation	Days transplant remains in host	Condition of disc
7–	7+	6	Completely differentiated
7–	7+	6	Completely differentiated
7–	7	5	Completely differentiated
7+	8	4½	Completely differentiated
7	8	4½	Completely differentiated
7	8	4½	Completely differentiated
7	8	4½	Completely differentiated
7	8	4½	Completely differentiated
7	8+	4	Completely differentiated
7	8+	4	Completely differentiated
7	8+	4	Completely differentiated
7+	9–	4	Completely differentiated
7+	9–	4	Completely differentiated
7	9	4	Not quite completely differentiated
7–	9	4	Partly sclerotized, bristles formed
7–	9	4	Partly sclerotized, bristles formed
7	9	3	Not quite completely differentiated
7	9	3	Not quite completely differentiated
7	9	3	Partly sclerotized, large white regions, no bristles
7	9	3	Partly sclerotized, large white regions, no bristles
7	9	3	Partly sclerotized, large white regions, no bristles

Worthy of comment in this connection is another experiment in which the imaginal eye disc of donor larvae of stage 7 (two cases) and stage 9 (three cases) were transplanted into the abdominal cavity of

hosts of the same age. In the cases reported above, where thoracic discs were transplanted into only slightly older hosts, the transplants always developed synchronously with the host and gave rise to a fully developed imaginal eye in the abdominal cavity. The only difference between a normal and a transplanted eye is that the lenses of the latter are directed toward the inside of the eye instead of projecting from the outer surface of the cup as in normal development. This peculiar situation has a very simple explanation. The elongated and flat cup-shaped imaginal eye of the larva contracts somewhat when dissected and rounds up after transplantation in such a way that the outer surface is folded inwards. It thus forms a hollow ball in which the retinal part of the ommatidia makes up the outer wall, while the part which forms the lenses is the inner surface. One can note further in these cases that the ommatidia of the transplants are much shorter than those in a normal eye. This is undoubtedly due to the abnormal spatial conditions the developing eye encounters in its new environment. Thus, purely mechanical factors restrict the increase in length of the ommatidia of the transplant (Bodenstein, 1939).

Discussion

The experiments have shown that growth of larval tissues can be greatly modified by altering the environment in which these tissues develop. Thus, identical Malpighian tubes grow best in a larval environment, and less well in the pupal and adult environments, respectively. True, the amount of growth in an adult host is quite small as compared with that in a larval host, yet growth may be considerable, even in an adult host, if the time the organ is allowed to remain in the adult host is increased. In other words, growth proceeds at a much slower rate in an adult environment. No matter how much growth is slowed down, there remains the essential fact that young larval Malpighian tubes can grow in an adult environment.

Quite different is the course of events taken by larval discs of the last larval instar. These organs do not grow at all when transplanted into adult hosts. Now these organs differ in two main aspects from the Malpighian tubes, and these differences seem to account for their different behavior. First, the imaginal discs grow mainly by cell multiplication, in contrast to the Malpighian tubes which grow by increase in cell size. Secondly, the transplanted discs came from last instar donor larvae; thus, they were physiologically much older organs than the Malpighian tubes. The main reason why the discs fail to grow in the adult environment must apparently be attributed to the loss of competence of these organs to respond to growth-promoting factors present in the adult animal. That these factors exist is shown by the growth of Malpighian tubes in the same environment.

There are, however, other possibilities to be reckoned with. The factors causing growth in Malpighian tubes might be different from

those needed by the imaginal discs for their growth. But even if these factors are the same, there remains the possibility that their effectiveness in the adult environment is too low to promote growth in the imaginal discs, yet high enough to cause the Malpighian tubes to grow. A combination of these possibilities will apparently prove to be the real state of affairs encountered. As far as the Malpighian tubes are concerned, one finds that the growth factors are much more effective in a larval than in an adult environment, for identical Malpighian tubes, that is, organs which obviously have the same growth competence, grow better in a larval than in an adult environment. Moreover, these growth factors must gradually fall off as the animal approaches its imaginal state, since Malpighian tubes grow best in the larval, less well in the pupal and but little in adult hosts.

It has been seen that the growth competence, that is, the ability of an organ to respond with growth when called upon, varies within different organs. Apparently, the situation in regard to differentiation is similar. Identical discs will differentiate when transplanted into larvae, differentiation is less complete when they are transplanted into pupae, and no differentiation at all occurs in those discs grown in adult hosts. The same factors causing differentiation must be present in larvae; they must be less active in pupae and are apparently absent in the adult. This, however, is at best a rough generalization of the actual situation prevailing, as a close analysis of the different experimental series will show. Considering first the transplantation of discs into pupae, the following interesting facts become evident. If discs of stage 8– to 8 are grown in the pupal hosts, some sclerotization occurs, but no imaginal structures, such as hairs or bristles, develop. On the other hand, discs of stage 7– to 7, grown in the same environment, do not differentiate any cuticular structures. Since stage 8 discs are able to differentiate, it follows that the pupal host contains the factors necessary for differentiation. The reason that stage 7 discs do not differentiate must therefore lie in the discs themselves, for they are apparently unable to respond to these differentiation factors. Yet the situation is somewhat more complicated, as is brought out by the following consideration. True, stage 7 discs cannot respond with differentiation as stage 8 discs can, but these young discs continue their development in the pupal host, as indicated by their growth. In the pupal host they should reach stage 8, that is the reactive stage, and this they apparently do. Why then do they not differentiate after having reached this stage? The answer to this is given in the experimental series where discs of stages 7 and 8 were transplanted into adult hosts. In these cases even discs of stage 8 did not differentiate, which shows that the differentiation factors are missing in this environment. Therefore, we must assume that the young discs in the pupal environment reach their reactive stage at a time when the differentiation factors in the pupae have already disappeared or are so weakened as to be unable to cause differentiation.

The gradual disappearance of the differentiation factors during the course of pupal development becomes evident also in the experiments where stage 7 discs were transplanted into larvae of different ages (Table 47). One finds that discs of about stage 7 transplanted into larvae of stages 7 to 9– differentiate completely, while the same discs transplanted into stage 9 differentiate only partially. Since in this group of experiments all of the transplants remained for the same length of time in the pupal host but for various lengths of time in the larval host, it follows that their different developmental behavior must be attributed to the different lengths of time that they remained in the larval host. In other words, the transplants growing in younger hosts reached their responsive stage at a time when the differentiation factors were still present in the pupae and hence differentiated completely, while the transplants in older hosts reached this stage too late and could not get the full benefit of the differentiation factors, which resulted in partial differentiation only. Now there is one more point to be mentioned in this connection. In the case of complete imaginal differentiation, host and transplanted tissue apparently differentiate in synchrony with each other, although at the time of transplantation the transplanted discs and the hosts were of unequal age. Thus, some sort of regulation must have occurred. This can be explained as follows: under the influence of the differentiation factors of the host, the young discs must have started their imaginal differentiation earlier than they would have if left in their own environment. Either the young discs have grown faster and reached their responsive stage earlier than they would have in their own environment, or the differentiation factors were able to induce differentiation in the transplanted discs earlier, and the discs then have responded earlier than normally. According to the observation on other flies (Bodenstein, 1943), it is likely that both had occurred.

The experiments discussed above have brought to light the existence of growth and differentiation promoting factors in the organic environment of the transplant; and it has been recognized that in order to grow and differentiate, the transplant itself has to be competent to respond to these factors. Yet so far nothing has been said about the nature of these environmental factors. This question will now be discussed. In all experiments the transplants were placed into the abdominal cavity of the host, where they floated freely in the body fluid. The most intimate connection the transplants had with their hosts was thus the blood medium. The environmental factors we speak of are apparently located there. Obviously, the different environments tested have each their peculiar nutritive condition; therefore, one might think that nutritive factors are responsible for the developmental behavior of the transplant. In this case, the different competence of the transplanted organs would be the expression of their varied ability to utilize the different foodstuffs. However, nutritive factors are certainly not the main reason for the observed behavior of the transplanted organs, for experiments on *Drosophila* have shown that hormones circulating in the blood of the host animal control the

developing organ to a large extent (Bodenstein, 1943). That the effects observed in the experiments reported here are also due to the action of such hormones becomes very probable if one recognizes the similarity in the results obtained in these and the previous experiments on *Drosophila.*

Summary

Malpighian tubes from egg larvae of Aedes were transplanted into the abdominal cavity of larval, pupal and adult animals. These organs grow best in larval, less well in the pupal and only a little in adult environment.

Imaginal discs were likewise transplanted into a larval, pupal and adult environment. In an adult host these discs are unable to differentiate. In a pupal host, the discs grow and begin to sclerotize. Sclerotization is, however, not complete. Discs transplanted into a larval environment and dissected at the emergence of the fly show complete imaginal differentiation.

Factors necessary for the differentiation of the imaginal discs are present in the late larval and young pupal hosts. These disappear, however, as the pupae become older. These factors, apparently hormonal in nature, are responsible also for the synchrony of development observed between transplant and host tissue. Younger tissues in older hosts will differentiate earlier than they would if left in their own environment. Discs of different age respond differently to the factors necessary for their differentiation.

Literature Cited

Beadle and Ephrussi. A Technique of Transplantation for Drosophila. Am. Naturalist. 70, 1936.

Bodenstein, D. Hormones and Tissue Competence in the Development of the Drosophila. Biological Bulletin Vol. 84:34-58. 1943.

Bodenstein, D. Investigation on the Problem of Metamorphosis. IV. Developmental Relations of Interspecific Organ Transplants in Drosophila. Journal Experimental Zool., 82:1-30, 1939.

Bodenstein, D. The Induction of Larval Molts in Drosophila. Biological Bulletin, 86:113-124. 1945.

MISCELLANEOUS INSECT NOTES

Elm Lacebug (*Corythuca ulmi* O. and D.) This insect was very abundant on elms in Litchfield County. It is a sucking insect and is found on the under side of the leaves. By the middle of August most of the leaves had turned brown. We received several calls from people who were afraid the elms were infected with the Dutch elm disease.

M. P. Zappe

Termites (*Reticulitermes flavipes* Koll.) During 1945 we investigated 34 complaints of termites causing damage to homes and other buildings. In many cases the damage was slight and the owner was advised how to check it without expenditure of large sums of money. Occasionally the case called for some reconstruction work that was too big a job for the householder. As there was a shortage of carpenters and it was practically impossible to obtain copper flashing, a few people were advised to do nothing for a while until material and help could be obtained. Contrary to popular belief termites do not work very rapidly and a short delay in control measures would make very little difference in the amount of damage or in the final cost of eradication.

In most of the cases the owners reported the insects present before any serious damage was done. Only in one case was damage serious enough to warrant immediate reconstruction and this was in a farm house where termites had been present for quite a few years.

M. P. Zappe

PUBLICATIONS, 1945[1]

R. B. Friend

Entomology. The American Year Book, Year 1944, pp. 800-807. July, 1945.

The Gypsy Moth in Connecticut. Trans. of the Conn. Academy of Arts and Sciences, Vol. 36, pp. 607-629. July, 1945.

The Timing of Insect Control Operations. Plants and Gardens (Brooklyn Botanic Garden Record), Vol. 1, No. 2, New Series, pp. 113-115. 1945.

Raimon L. Beard

Studies on the Milky Disease of Japanese Beetle Larvae. Bul. 491, 82 pp., 27 figs. August, 1945.

Philip Garman

The Season's Insect Situation. Pomological Pointers for Conn. Fruit Growers, No. 176 (1 column). April, 1945.

1944 Report on Parasites. Proc. 54th Annual Meeting, Conn. Pom. Soc., pp. 86-87. May, 1945.

Trends in Insect Control. Proc. 54th Annual Meeting, Conn. Pom. Soc., pp. 29-34. May, 1945.

Further Studies of Apple Spray Schedule Reduction. Jour. Econ. Ent., Vol. 38, No. 3, pp. 341-343. June, 1945.

Seventeen-year Locust or Periodical Cicada, with a Few Notes on Other Insect Pests. Pomological Pointers for Conn. Fruit Growers, No. 178 (1½ columns). June, 1945.

A Study of Stickers for Lead Arsenate Sprays on Fruit Trees. Bul. 485, 52 pp., 19 figs. August, 1945.

Philip Garman, R. B. Friend, C. H. Gowdy

Insects of 1944. Proc. 54th Annual Meeting, Conn. Pom. Soc., pp. 81-82. May, 1945.

Neely Turner

The Coverage Factor in the Application of Dusts. Jour. Econ. Ent., Vol. 38, No. 3, pp. 359-364. June, 1945.

[1] Inasmuch as the articles in this Report written by members of the Department all bear the authors' names, they are not listed here.

GEORGE A. ZENTMYER AND PHILIP P. WALLACE

New Research on the Dutch Elm Disease. Proc. 20th Nat'l. Shade Tree Conf., 1944. pp. 115-119. January, 1945.

GEORGE A. ZENTMYER, PHILIP P. WALLACE, AND JAMES G. HORSFALL

Distance as a Dosage Factor in the Spread of Dutch Elm Disease. Phytopathology, Vol. 34, No. 12, pp. 1025-1033. December, 1944.

R. C. BOTSFORD (State Board of Mosquito Control)

Directions for the Elimination of the Mosquito Nuisance. Spec. Bul. (mimeographed), 3 pp. Feb., 1945.

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Bulletin 502 December, 1946

COMMERCIAL FERTILIZERS

REPORT FOR 1946

H. J. Fisher
Chemist in Charge

Connecticut
Agricultural Experiment Station
New Haven

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.

CONTENTS

Report on Inspection and Analysis of Commercial Fertilizers, 1946

H. J. Fisher, *Chemist in Charge*[1]

CONNECTICUT LAW AND REGULATIONS REGARDING COMMERCIAL FERTILIZERS

The term "commercial fertilizers" as used in the Connecticut fertilizer statute includes any and every substance imported, manufactured, prepared or sold for fertilizing or manuring or soil amendment purposes, except barnyard manure and stable manure that have not been artificially treated or manipulated, marl and lime. But no commercial fertilizer containing less than 0.82 per cent of nitrogen, or less than 1 per cent of phosphoric acid, or less than 1 per cent of potash is acceptable for registration.

The seller is responsible for the proper labelling of each package of fertilizer, for the registration of each brand sold or offered for sale, for the payment of the required analysis fee and for the payment of the tonnage tax. If, however, proper labelling, registration and payments of analysis fees and of tonnage tax have been provided for by the manufacturer or by another responsible person, all sellers of such brands are released from the above-mentioned requirements. The retailer, therefore, should assure himself that the requirements of the law have been met by the manufacturer of the brands which he handles, or himself be prepared to meet all these requirements.

It frequently happens that a manufacturer or jobber sells fertilizer materials which are the products of, and which are registered by, another firm or individual. Distributors in such cases should sell such materials by the exact brand names under which they are registered in order that there may be no mistake as to the identity of brands. Any change in the brand names, or failure to make the identity of the brand and its manufacturer clear, makes the distributor liable for the registration of the product as his own brand.

The law exempts from registration, and from other requirements referred to, only (1) fertilizers passing through the State in transit; (2) fertilizers and fertilizer materials shipped to regular fertilizer factories to be used for manufacturing purposes, and (3) fertilizers and fertilizer chemicals sold to the Connecticut Agricultural Experiment Station for experimental purposes.

[1] E. M. Bailey was in charge of the Department of Analytical Chemistry until his retirement on October 1, 1945. Analyses reported were made by Messrs. O. L. Nolan, Richard Merwin, D. C. Walden (deceased), Alphonse Wickroski and Miss Helen Kocaba; inspection and sampling by Messrs. George Smith and Richard Nichols; and compilations by Mr. Nolan and Mrs. M. B. Vosburgh.

Cottonseed, linseed and soybean meals, when sold or used for fertilizer purposes, must be registered as fertilizers and the specified fees paid thereon. For such products the registration fee is $10.00 for each brand, payable annually, and six cents per ton tonnage fee, payable semi-annually.

These fees are entirely apart from those required by the feeding stuffs statute.

Because manufacturers or jobbers do not know how much, if any, of their vegetable meal tonnage is sold or used as fertilizer, local dealers and purchasers report their sales or purchases to this Station. The information is not for publication but is used to inform manufacturers of the total sales of their meal as fertilizer in this State. It is expected that the fees provided for by statute will be paid by the manufacturer or other party responsible for the brands.

Official Definitions of Fertilizer Terms and Materials[1]

An *acid-forming fertilizer* is one that is capable of increasing the residual acidity of soil.

A *non-acid-forming fertilizer* is one that is not capable of increasing the residual acidity of the soil.

Acidulated fish tankage or acidulated fish scrap is the rendered product derived from fish and treated with sulfuric acid.

Activated sewage products are those made from sewage freed from grit and coarse solids and aerated after being inoculated with microorganisms. The resulting flocculated organic matter is withdrawn from the tanks, filtered with or without the aid of coagulants, dried, ground and screened.

Agricultural liming material is material whose calcium and magnesium content is capable of neutralizing soil acidity.

Air-slaked lime is a product composed of varying proportions of the oxide, hydroxide and carbonate of calcium, or of calcium and magnesium, and derived from exposure of quicklime.

Ammoniated superphosphate is the product obtained when superphosphate is treated with ammonia or with a solution containing free ammonia and other forms of nitrogen dissolved therein.

The word *analysis*, as applied to fertilizers, shall designate the percentage composition of the product expressed in those terms that the law requires and permits.

Ashes from leached wood are unleached ashes resulting from burning wood that has been exposed to or digested in water or other

[1] Cited from Methods of Analysis, 6th Ed. 1945, Association Official Agricultural Chemists.

liquid solvent, as in the extraction of dyes, so that a part of the plant food has been dissolved and removed.

Available phosphoric acid is the sum of the water-soluble and the citrate-soluble phosphoric acid.

"Basic" lime phosphate (lime-based superphosphate) is a superphosphate to which liming materials have been added in a quantity at least six per cent (6%) calcium carbonate equivalents in excess of the quantity required to convert all water-soluble phosphate to the citrate-soluble form.

Basic phosphate slag is a by-product in the manufacture of steel from phosphatic iron ores. The product shall be finely ground and shall contain no admixture of materials other than what results in the original process of manufacture. It shall contain not less than twelve per cent (12%) of total phosphoric acid (P_2O_5), not less than eighty per cent (80%) of which shall be soluble in two per cent (2%) citric acid solution according to the Wagner method of analysis, **2.19** or **2.20.** Any phosphate slag not conforming to this definition shall be designated *low grade.*

Bat guano is partially decomposed bat manure.

Bat manure is the dry excrement from bats.

A *brand* is a term, design or trademark used in connection with one or several grades of fertilizers.

A *brand name* is a specific designation applied to an individual fertilizer.

Calcium nitrate (nitrate of lime) is a commercial product consisting chiefly of calcium nitrate, and it shall contain not less than fifteen per cent (15%) of nitrogen.

Citrate-soluble ("reverted") phosphoric acid is that part of the total phosphoric acid in fertilizer that is insoluble in water but soluble in a solution of citrate of ammonia according to the method adopted by the Association of Official Agricultural Chemists.

Crude, inert, or slow-acting nitrogenous materials are unprocessed organic substances relatively high in nitrogen but having a very low value as plant food and showing a low activity by both the alkaline and neutral permanganate methods (below 50% and 80%, respectively).

Cyanamid is a commercial product composed chiefly of calcium cyanamide ($CaCN_2$), and it shall contain not less than twenty-one per cent (21%) of nitrogen.

Dicalcium phosphate is a manufactured product consisting chiefly of a dicalcic salt of phosphoric acid.

Dissolved bone is ground bone or bone meal that has been treated with sulfuric acid.

Dolomite is a mineral composed chiefly of carbonates of magnesium and calcium in substantially unimolal (1-1.19) proportions.

Dried blood is the collected blood of slaughtered animals, dried and ground and containing not less than twelve per cent (12%) of nitrogen in organic forms.

Dried, pulverized, or shredded manures are what the name indicates, and not mixtures of manures and other materials.

Fertilizer grade shall represent the minimum guaranty of its plant food expressed in terms of *nitrogen (not ammonia)*, *available phosphoric acid*, and *water-soluble potash*.

Fish tankage, fish scrap, dry ground fish or *fish meal fertilizer grade*, is the dried ground product derived from rendered or unrendered fish.

Garbage tankage is the rendered, dried and ground product derived from waste household food materials.

Pulverized limestone (*fine-ground limestone*) is the product obtained by grinding either calcitic or dolomitic limestone so that all the material will pass a 20-mesh sieve and at least seventy-five per cent (75%) will pass a 100-mesh sieve.

Ground limestone (*coarse-ground limestone*) is the product obtained by grinding either calcitic or dolomitic limestone so that all the material will pass a 10-mesh sieve, and at least fifty per cent (50%) will pass a 100-mesh sieve.

Ground shells is the product obtained by grinding the shells of mollusks so that not less than fifty per cent (50%) shall pass a 100-mesh sieve. The product shall also carry the name of the mollusk from which said product is made.

Ground shell marl is the product obtained by grinding natural deposits of shell marl so that at least seventy-five per cent (75%) shall pass a 100-mesh sieve.

Ground raw bone is dried ground animal bones that have not been steamed previously under pressure.

Ground steamed bone is ground animal bones that have been steamed previously under pressure.

Gypsum, land plaster or *crude calcium sulfate* is a product consisting chiefly of calcium sulfate. It may contain twenty per cent (20%) of combined water. (It does not neutralize acid soils.)

High calcic products are materials of which ninety per cent (90%) or more of the total calcium and magnesium content consists of calcium oxide.

High magnesic products are materials in which more than ten per cent (10%) of the total calcium and magnesium oxide consists of magnesium oxide.

Hoof and horn meal is processed, dried, ground hoofs and horns.

Hydrated or slaked lime is a dry product consisting chiefly of the hydroxide of calcium and oxide-hydroxide of magnesium.

Kainit is a potash salt containing potassium and sodium chlorides and sometimes sulfate of magnesia with not less than twelve per cent (12%) of potash (K_2O).

Leached wood ashes are ashes from burned unleached wood with part of their plant food removed by artificial means or by exposure to rains, snows, or other solvent.

The word *lime* when applied to liming materials means either calcium oxide or calcium and magnesium oxides.

Magnesia (magnesium oxide) is a product consisting chiefly of the oxide of magnesium. Its grade shall be stipulated. Example: Magnesia – 75 per cent MgO.

Manganese. The water-soluble (or available) manganese in fertilizers shall be expressed as manganese (Mn).

Manganese sulfate. The term manganese sulfate, when applied to an ingredient of a mixed fertilizer, shall designate anhydrous manganous sulfate ($MnSO_4$).

Manure salts are potash salts containing high percentages of chloride and from twenty per cent (20%) to thirty per cent (30%) of potash (K_2O). The term *double manure salts* should be discontinued.

Monoammonium phosphate (*fertilizer grade*) is a commercial salt made by combining phosphoric acid with ammonia. It shall contain not less than ten per cent (10%) of nitrogen and not less than forty-six per cent (46%) of available phosphoric acid.

Muriate of potash (commercial potassium chloride) is a potash salt containing not less than forty-eight per cent (48%) of potash (K_2O), chiefly as chlorides.

Nitrate of ammonia (ammonium nitrate) is a product composed chiefly of nitrate of ammonium. Its nitrogen content shall be stipulated. Example: Ammonium nitrate – 30 per cent N.

Nitrate of potash (commercial potassium nitrate) is a salt containing not less than twelve per cent (12%) of nitrogen and forty-four per cent (44%) of potash (K_2O).

Nitrate of soda (commercial sodium nitrate) is commercial sodium nitrate containing not less than fifteen per cent (15%) of nitrogen, chiefly as sodium nitrate.

Nitrate of soda and potash is a commercial product containing nitrates of sodium and potassium, and it shall contain not less than fourteen per cent (14%) of nitrogen (N) and fourteen per cent (14%) of potash (K_2O).

Peat is a partly decayed vegetable matter of natural occurrence. It is composed chiefly of organic matter that contains some nitrogen of low activity.

Charred peat is peat artificially dried at a temperature that causes partial decomposition.

Phosphate rock is a natural rock containing one or more calcium phosphate minerals of sufficient purity and quantity to permit its use, either directly or after concentration, in the manufacture of commercial products.

The term *phosphoric acid* designates phosphorus pentoxide (P_2O_5).

The term *potash* designates potassium oxide (K_2O).

Precipitated bone phosphate is a by-product from the manufacture of glue from bones and is obtained by neutralizing the hydrochloric acid solution of processed bone with calcium hydroxide. The phosphoric acid is chiefly present as dicalcium phosphate.

Precipitated phosphate is a product consisting mainly of dicalcium phosphate obtained by neutralizing with calcium hydroxide the acid solution of either phosphate rock or processed bone.

Primary fertilizer components are those at present generally recognized by law as necessary to be guaranteed in fertilizers, namely: nitrogen, phosphoric acid (P_2O_5), and potash (K_2O).

Secondary fertilizer components are those other than the "primary fertilizer components" that are essential to the proper growth of plants and that may be needed by some soils. Some of these components are calcium, magnesium, sulfur, manganese, copper, zinc and boron.

Process tankages are products made under steam pressure from crude inert nitrogenous materials, with or without the use of acids, for the purpose of increasing the activity of the nitrogen. These products shall be called "Process Tankages" with or without further qualification. The water-insoluble nitrogen in these products shall test at least fifty per cent (50%) active by the alkaline, or eighty per cent (80%) by the neutral permanganate method.

Products secured by heating calcium phosphate with alkali salts containing potash are non-acid phosphates with potash. They are *not* potassium phosphate.

Quick lime, burned lime, caustic lime, lump lime, unslaked lime. These designations shall apply to calcined materials, the major part

of which is calcium oxide, in natural association with a lesser amount of magnesium oxide, and which is capable of slaking with water.

Sheep manure—wool waste is the by-product from wool-carding establishments consisting chiefly of sheep manure, seeds, and wool fiber.

Soft phosphate with colloidal clay is a very finely divided low-analysis by-product from mining Florida rock phosphate by a hydraulic process in which the colloidal materials settle at points in artificial ponds and basins farthest from the washer, and are later removed after the natural evaporation of the water.

Sulfate of ammonia (*commercial ammonium sulfate*) is a commercial product composed chiefly of ammonium sulfate. It shall contain not less than twenty and five-tenths per cent (20.5%) of nitrogen.

Sulfate of potash-magnesia is a potash salt containing not less than twenty-five per cent (25%) of potash (K_2O), nor less than twenty-five per cent (25%) of sulfate of magnesia, and not more than two and one-half per cent (2.5%) of chlorine.

Sulfate of potash (*commercial potassium sulfate*) is a potash salt containing not less than forty-eight per cent (48%) of potash (K_2O) chiefly as sulfate, and not more than two and one-half per cent (2.5%) of chlorine.

Superphosphate is a commercial phosphate, the phosphoric acid (P_2O_5) content of which is due chiefly to monocalcium phosphate. (The grade that shows the available phosphoric acid should always be used as a prefix to the name. Example: 16 per cent superphosphate.)

Tankage (without qualification) is the rendered, dried and ground by-product, largely meat and bone from animals (slaughtered or that have died otherwise).

A unit of plant food is twenty (20) pounds, or one per cent (1%) of a ton.

Unleached wood ashes are ashes from burned unleached wood that have had no part of their plant food removed and that contain four per cent (4%) or more of water-soluble potash (K_2O).

Waste lime, by-product lime, is any industrial waste or by-product containing calcium or calcium and magnesium in forms that will neutralize acids. It may be designated by prefixing the name of the industry or process by which it is produced, i.e., gas-house lime, tanners' lime, acetylene lime-waste, lime-kiln ashes, calcium silicate, etc.

REGISTRATIONS

Late Registrations for 1945

To the brands registered for 1945 in our last report should be added:

Eastern States Farmers' Exchange, West Springfield, Mass.
Eastern States 0–20–20

Registrations for 1946

For 1946, 56 firms and individuals registered 243 brands of fertilizers at this Station for sale in the State. As required by statute, the brands are listed as follows:

Acme Guano Co., Baltimore, Md.
Acme 4–12–4
Acme 5–8–7
Acme 5–10–5
Acme 5–10–10
Acme 7–7–7

Agricultural Supply Co., West Haven, Conn.
Yale Special Mixture 8–6–2

Ted Alkire, Lubbock, Tex.
Kireal Cotton Hull Ash

Allied Chemical & Dye Corp., 40 Rector St., New York 6, N. Y.
Arcadian, The American Nitrate of Soda
Arcadian Sulphate of Ammonia
Sulphate of Ammonia

American Agricultural Chemical Co., No. Weymouth 91, Mass.
AA Quality Fertilizer 5–8–7
AA Quality Fertilizer 5–10–10
Agrico Country Club Fertilizer 6–10–4
Agrico for Corn 3–12–6[1]
Agrico for Corn 4–12–8
Agrico for Gardens 4–12–4
Agrico for Gardens 5–10–5
Agrico for Lawns, Trees and Shrubs 4–12–4
Agrico for Lawns, Trees and Shrubs 6–10–4
Agrico for New England 4–10–10
Agrico for New England 5–8–7
Agrico for Potatoes 5–10–10
Agrico for Seeding Down 4–12–16
Agrico for Tobacco 6–3–6
Agrico for Top Dressing 7–7–7
Agrico Phosphate and Potash 0–14–14
18% Normal Superphosphate
Pulverized Sheep and Goat Manure

American Cyanamid Co., 30 Rockefeller Plaza, New York 20, N. Y.
20.6% 'Aero' Cyanamid Granular
Ground Raw Phosphate Rock

American Potash & Chemical Corp., 122 E. 42nd St., New York, N. Y.
Trona Muriate of Potash

American Sumatra Tobacco Corp., 102 Maiden Lane, New York 5, N. Y.
Soybean Meal, 41%

Apothecaries Hall Co., Waterbury, Conn.
Bone Meal
Carbonate of Potash
Castor Pomace
Cotton Hull Ashes
Dry Ground Fish
Liberty Fertilizer 0–14–14
Liberty Fertilizer 0–20–20
Liberty Fertilizer 4–12–4
Liberty Fertilizer 5–10–5
Liberty Fertilizer 5–10–10
Liberty Fertilizer Special for Fruit and Grass 7–7–7
Liberty Fertilizer with Sulphate of Potash 5–10–10
Liberty Green Gro Fertilizer 6–7–4
Liberty High Grade Market Gardeners 5–8–7
Liberty High Grade Market Gardeners with Sulphate of Potash 5–8–7
Liberty Home Garden Fertilizer 5–10–5
Liberty Tobacco Mixture 5–3–5
Liberty Tobacco Mixture 6–3–6
Liberty Tobacco Mixture with Cotton Hull Ashes 6–3–6
Liberty Tobacco Starter 4–10–0
Liberty Tobacco Starter 5–5–15
Muriate of Potash
Nitrate of Potash
Precipitated Bone
Sheep Manure
Sulphate of Ammonia
Sulphate of Potash
Superphosphate 20%

Archer-Daniels-Midland Co., Minneapolis 2, Minn.
Archer Quality 32% Protein Old Process Linseed Oil Meal
Archer Quality 34% Protein Old Process Linseed Oil Meal
Archer Quality 41% Protein Soybean Oil Meal
Archer Quality 44% Protein Soybean Oil Meal

Armour Fertilizer Works, 120 Broadway, New York 5, N. Y.
Armour's Big Crop Fertilizer 0–14–7
Armour's Big Crop Fertilizer 0–14–14
Armour's Big Crop Fertilizer 4–12–4
Armour's Big Crop Fertilizer 5–8–7
Armour's Big Crop Fertilizer 5–10–5
Armour's Big Crop Fertilizer 5–10–10
Armour's Big Crop Fertilizer 7–7–7
Armour's Big Crop Fertilizer 8–16–16
Armour's Big Crop Tobacco Special 5–3–5
Armour's Big Crop Tobacco Special 6–3–6
Armour's Big Crop Superphosphate 20%
Armour's Bone Meal Fertilizer
Armour's Pulverized Sheep Manure
Armour's Special Ornamental Fertilizer 6–12–4
Castor Pomace

Ashcraft-Wilkinson Co., Atlanta 3, Ga.
Cow-Eta Brand 41% Protein Cottonseed Meal
Gilt Edge Brand Old Process 41% Soya Meal
Nitraprills Fertilizer Compound Chemically Prepared

Associated Seed Growers Inc., Milford, Conn.
Asgrow Lawn Food 10–6–4

Atkins & Durbrow, Inc., 165 John St., New York 7, N. Y.
Driconure

The F. A. Bartlett Tree Expert Co., Stamford, Conn.
Bartlett Green Tree Food 4–8–6
Bartlett Green Tree Food 6–8–6

The Berkshire Chemical Co., Bridgeport, Conn.
Berkshire Fertilizer 0–14–14
Berkshire Fertilizer 4–12–4
Berkshire Fertilizer 5–8–7
Berkshire Fertilizer 5–10–5
Berkshire Fertilizer 5–10–10
Berkshire Fertilizer 7–7–7
Berkshire Specialty Fertilizer 6–6–4
Berkshire Tobacco Fertilizer 6–3–6

Chilean Nitrate Sales Corp., 120 Broadway, New York 5, N. Y.
Chilean Nitrate of Soda—Champion Brand
Chilean Nitrate of Soda—Original Old Style

Consolidated Rendering Co., 178 Atlantic Ave., Boston 10, Mass.
Corenco 0–14–14 Top Dresser
Corenco 4–12–4 Complete Manure
Corenco 5–8–7 Potato and General Crop
Corenco 5–10–5 Home Garden Fertilizer
Corenco 5–10–10 Peerless Potato
Corenco 6–3–6 Special Tobacco Grower
Corenco 7–7–7 Complete Fruit and Top Dressing
Corenco 8–6–4 Landscape Fertilizer
Corenco Ground Bone
Corenco Sheep Manure
Corenco Superphosphate 20%

The Davey Tree Expert Co., Kent, Ohio
Davey Shredded Manure
Davey Tree Food 12–4–4

Davison Chemical Corp., Baltimore, Md.
Davco Granulated Fertilizer 5–10–10
Davco Granulated 20% Superphosphate

E. I. du Pont de Nemours & Co., Wilmington 98, Del.
Dupont Uramon Fertilizer Compound

Eastern States Farmers' Exchange, West Springfield, Mass.
Cottonhull Ash 30%
Eastern States 0–19–19 W/Borax
Eastern States 0–20–20
Eastern States 5–10–5 V.G.
Eastern States 5–10–10
Eastern States 5–15–5
Eastern States 5–15–20
Eastern States 8–4–8
Eastern States 8–16–16
Eastern States 8–16–16 LCS
Eastern States 8–24–8
Eastern States 10–10–10
Eastern States Superphosphate Granulated and Pulverized (20%)
Eastern States Triple Superphosphate 47%
Muriate of Potash 60%
Sulphate of Potash 48%

Ford Motor Co., Dearborn, Mich.
Ford Ammonium Sulphate

A. H. Hoffman, Inc., Landisville, Lancaster County, Pa.
Hoffman Sheep Manure (Kiln-Dried)

Hollandale Cotton Oil Co., Hollandale, Miss.
41% Protein Cottonseed Meal

Spencer Kellogg & Sons, Inc., 98 Delaware Ave., Buffalo 5, N. Y.
Castor Pomace
Spencer Kellogg's 41% Protein Soybean Oil Meal

L. B. Lovitt & Co., Memphis, Tenn.
"Lovit Brand" 36% Protein Cottonseed Meal
"Lovit Brand" 41% Protein Cottonseed Meal

McCormick & Co., Inc., Baltimore 2, Md.
Hy-Gro 13–26–13

Miller Chemical & Fertilizer Corp., Baltimore 31, Md.
VHPF 5–25–15

Norwood Brand Fertilizer Co., No. Reading, Mass.
Norwood Brand Sheep Manure

Old Deerfield Fertilizer Co., Inc., So. Deerfield, Mass.
Old Deerfield 5–8–7 All Crop Fertilizer
Old Deerfield 5–5–15 Tobacco
Old Deerfield 5–10–10 Potato Fertilizer
Old Deerfield 6–3–6 Complete Tobacco Fertilizer
Old Deerfield Castor Pomace 5.5%
Old Deerfield Cottonhull Ashes 35%
Old Deerfield Double Sulfate of Potash Magnesia 21.5%
Old Deerfield Dry Ground Fish 9.5% and 5.00%
Old Deerfield Hoof and Horn Meal
Old Deerfield Steamed Bone 2.47%

Olds & Whipple, Inc, Hartford, Conn.
O & W 4–8–4 Complete Lawn Grass Fertilizer
O & W 4–12–4 Market Garden Fertilizer
O & W 5–3–5 Complete Tobacco Fertilizer
O & W 5–3–5 Complete Tobacco Fertilizer Potash derived from Cotton Hull Ash
O & W 5–5–15 High Grade Tobacco Starter and Potash
O & W 5–8–7 Potato and General Purpose Fertilizer
O & W 5–8–7 Potato and General Purpose Fertilizer with Sulphate of Potash
O & W 5–10–5 Fertilizer
O & W 5–10–10 Potato Fertilizer
O & W 6–3–6 Blue Label Tobacco Fertilizer
O & W 6–3–6 Blue Label Tobacco Fertilizer Potash derived from Cotton Hull Ash
O & W 7–7–7 Top Dressing and Grass Fertilizer
O & W Bone Meal
O & W Carbonate of Potash
O & W Castor Pomace
O & W Cotton Hull Ash
O & W Luxura 5–8–6
O & W Menhaden Dry Ground Fish
O & W Sulphate of Potash
O & W Superphosphate
O & W Triple Superphosphate

Plantspur Products Co., Jersey City, N. J.
Plantspur Fertilizer 4–4–2

The Frank S. Platt Co., New Haven 10, Conn.
Platts's Special 10–5–5 Lawn Dressing

Premier Peat Moss Corp., 535 Fifth Ave., New York, N. Y.
Premier-Nure

The Pulverized Manure Co., Chicago 9, Ill.
Wizard Brand Cow Manure
Wizard Brand Pulverized Sheep Manure

Ralston Purina Co., St. Louis, Mo.
Purina Plant Food 5–10–5

The Rogers & Hubbard Co., Portland, Conn.
Castor Pomace
Cotton Hull Ash
Dry Ground Fish
Gro-Fast Bone Meal
Gro-Fast Cow Manure
Gro-Fast Plant Food 5–8–5
Gro-Fast Sheep Manure
Hubbard High Potash Fertilizer 5–10–10
Hubbard Potato Fertilizer 5–8–7
Hubbard Raw Knuckle Bone Flour
Hubbard Tobacco Grower 6–3–6
Muriate of Potash
Red-H 0–14–14
Red-H 4–12–4
Red-H 4–12–8
Red-H 5–8–7
Red-H 5–10–5
Red-H 5–10–10
Red-H 7–7–7
Red-H 8–16–16
Red-H Sulphate of Potash
20% Superphosphate
Victory Garden Fertilizer 5–10–5

Ruhm Phosphate & Chemical Co., Mt. Pleasant, Tenn.
"Red Seal Brand Ruhm's Phosphate Rock 30%"

O. M. Scott & Sons Co., Marysville, Ohio
Scott's Turf Builder 8–8–4[2]

Sears, Roebuck & Co., Chicago 7, Ill.
Garden Master Plant Food 5–10–5
Garden Master Sheep Manure

The Sewerage Commission of the City of Milwaukee, Milwaukee 1, Wis.
Milorganite

Shelco Milling Co., Memphis 1, Tenn.
Shelco Brand 41% Protein Cottonseed Meal, Prime Quality

M. L. Shoemaker, Div. Wilson & Co., Inc., Philadelphia, Pa.
M. L. Shoemaker's "Swift-Sure" 4–10–0 Tobacco Starter
M. L. Shoemaker's "Swift-Sure" 6–3–6 Tobacco Fertilizer

Ernest W. Smith, Farmington, Conn.
Mr. O's Liquid Fertilizer 10–6–3

Southern Cotton Oil Co., Memphis, Tenn.
Sco-Co Brand 41% Protein Cottonseed Meal

A. E. Staley Manufacturing Co., Decatur, Ill.
Staley's Soybean Oil Meal

Stumpp & Walter Co., 132 Church St., New York 8, N. Y.
Sawco Bone
Sawco Emerald Grass 5–10–5
Sawco General Garden 5–10–5
Sawco Superphosphate
Sawconure

Summers Fertilizer Co., Inc., Baltimore 2, Md.
"Summers" 0–20–20 Fertilizer
"Summers" 5–10–10 Fertilizer
"Summers" 8–16–16 Fertilizer
"Summers" 10–10–10 Fertilizer
"Summers" 20% Superphosphate

Swift & Co., Plant Food Div., Baltimore, Md.
Red Steer Brand Superphosphate
Sheep Manure
Swift's Red Steer 5–8–7
Swift's Red Steer 5–10–5
Swift's Red Steer 5–10–10
Vigoro 4–12–4

Tennessee Corp., Lockland, Cincinnati 15, Ohio
5–10–5 Loma

I. P. Thomas & Son Co., Camden, N. J.
I. P. Thomas 4–12–8
I. P. Thomas 5–8–7
I. P. Thomas 5–10–10
I. P. Thomas 7–7–7
20% Superphosphate

Walker-Gordon Laboratory Co., Plainsboro, N. J.
Bovung

Stewart H. Willson, Thompsonville, Conn.
Willson's Old Enfield Tree Food 6–7–4

F. H. Woodruff & Sons, Inc., Milford, Conn.
Gro-Sod Lawn Food 10–6–4

The Woodruff Fertilizer Works, Inc., No. Haven, Conn.
Clark's Tip Top Fertilizer 5–8–7
Woodruff's Castor Pomace
Woodruff's 4–12–4 Fertilizer
Woodruff's 5–8–7 Fertilizer
Woodruff's 5–10–5 Fertilizer
Woodruff's 5–10–10 Fertilizer
Woodruff's 6–3–6 Tobacco Fertilizer
Woodruff's 7–7–7 Fertilizer
Woodruff's Lawn Fertilizer 10–6–4

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[1] Substituted for Agrico Country Club Fertilizer 8–6–2 which was discontinued.

[2] Later revised to "Scott's Turf Builder 8–7–3".

FERTILIZER INSPECTION FOR 1946

During the war, under War Food Order No. 5 only certain specified grades of fertilizers were permitted to be sold. This restriction was revoked as of September 30, 1945. Since that date there has been no legal compulsion on manufacturers to limit the number of grades that they sell. Agronomists and most manufacturers are agreed, however, that the manufacture of a multiplicity of grades serves no useful purpose; it raises the cost of fertilizer to the farmer and offers him no compensating advantage in increased yields. A meeting of the New England agronomists in Boston in November, 1945, discussed the question of grade limitation at considerable length; it was agreed that, under the present fertilizer laws, manufacturers could not be compelled to limit the number of grades that they sold, but it was the unanimous opinion that a voluntary limitation of grades would be to the advantage of both manufacturers and consumers. In the hope that it would serve as a guide to manufacturers, the agronomists approved the following list of fertilizer ratios and minimum grades for each ratio that in their opinion would include all grades of mixed fertilizers for which there was any need in New England:

Ratio	Minimum Grade	
0–1–1	0–14–14	
1–1–1	7– 7– 7	
1–1–3	5– 5–15	(Tobacco)
1–2–1	5–10– 5	
1–2–2	5–10–10	
1–3–2	4–12– 8	
1–3–3	4–12–12	(New Hampshire potato)
1–3–4	4–12–16	
2–1–2	6– 3– 6	(Tobacco)
2–3–4	5– 7–10	(Maine potato)
2–3–5	6– 9–15	(Maine potato)

During the season the Station agents have collected samples of all the registered brands that could be found in the State. A classification of these, including samples submitted by purchasers, is given in the following tabulation. The classification includes also tonnage data for the year July 1, 1945, to June 30, 1946. This tonnage includes vegetable meal tonnage bought by tobacco growers for their own use direct from sources outside the State. It does not include fertilizer distributed in the State under the Federal Agricultural Adjustment Program.

CLASSIFICATION OF FERTILIZER MATERIALS AND FERTILIZER TONNAGE

(Tonnage is for the period July 1, 1945 to June 30, 1946)

		Page	No. of samples	Tonnage	
I.	Containing chiefly nitrogen:				
	Nitrate of ammonia	24	2	259	
	Nitrate of soda	24	5	2,191	
	Sulphate of ammonia	24	2	104	
	Cyanamid and urea	24	5	149	
	Castor pomace	24	14	3,733	
	Cottonseed meal	25	134	4,389	
	Soybean meal		7	689	
	Horn and hoof meal	25	2	78	
	Linseed meal		0	90	
					11,682
II.	Containing chiefly phosphoric acid:				
	Superphosphate 20%	26	12	4,296	
	18 - 19%	26	1	562	
	47%	26	1	33	
	Precipitated bone	26	1	173	
					5,064
III.	Containing chiefly potash:				
	Carbonate of potash	27	10	416	
	Muriate of potash	27	2	425	
	Sulphate of potash	27	3	282	
	Sulphate of potash-magnesia	27	2	114	
	Cottonhull ashes	27	10	1,135	
					2,372
IV.	Containing nitrogen and phosphoric acid:				
	Dry ground fish	28	8	1,464	
	Ground bone	28	14	1,185	
	Other materials	29	1	325	
					2,974
V.	Containing nitrogen and potash:				
	Nitrate of potash		0	160	160
VI.	Mixed fertilizers:				
	Commercial mixtures	30	144	59,095[1]	
	Special and home mixtures	40	79	119	
					59,214
VII.	Miscellaneous:				
	Sheep manure, etc.	43	14	670	
	Limestone and similar materials	44	12	....	
	Fertilizers sold in small packages	45	16	....	
	Other miscellaneous materials	46	24	....	
	Check meals and fertilizers		42	....	
					670
	Totals		567		82,136

[1] For distribution of this tonnage see next page.

Mixed Fertilizer Tonnage

Grades Approved for Connecticut

Grade	Tons	Grade	Tons
0–14–14	721	5–15–20	97
0–19–19	101	6– 3– 6	17,543
0–20–20	181	7– 7– 7	3,201
4–12– 8	371	8– 4– 8	870
4–12–16	105	8–16–16	1,475
5– 5–15	478	10–10–10	404
5–10– 5	2,049	13–26–13	1
5–10–10	10,493		
		Total	38,090

Specialty and Other Grades

(Over 50 tons)

2– 1– 1	286	6– 6– 4	96
3–12– 6	233	6– 7– 4	178
4– 8– 6	74	6–10– 4	115
4–10– 0	517	8– 6– 2	254
4–10–10	159	8– 6– 4	119
4–12– 4	3,181	8– 8– 4	75
5– 3– 5	744	8–24– 8	575
5– 8– 5	128	10– 6– 4	104
5– 8– 7	13,943		
		Total	20,781

(Less than 50 tons)

0–10–20	5	6– 8– 2	11
0–14– 7	13	6–12– 4	7
4– 4– 2	22	8– 7– 3	30
4– 8– 4	39	10– 5– 5	31
5– 8– 6	21	10– 6– 3	1
5–15– 5	36	12– 4– 4	8
		Total	224
		Grand Total	59,095

I. Raw Materials Chiefly Valuable for Nitrogen

The principal sources of inorganic nitrogen used in fertilizers in the past have been nitrate of soda and sulphate of ammonia. During the 1945-1946 season there was still more nitrate of soda sold than of any other nitrogenous material, but the tonnage of another ammonium salt, nitrate of ammonia, exceeded that of sulphate of ammonia. Pure ammonium nitrate contains 35 per cent of nitrogen as against 21.2 per cent in the sulphate; the fertilizer grade was sold under a guaranty of 33.5 per cent nitrogen.

Other sources of nitrogen in considerable use are cyanamid and urea. Both of these are synthetic products made from inorganic raw materials, but for fertilizer purposes they are classed as sources of non-protein organic nitrogen.

The chief sources of organic nitrogen have been cottonseed meal and castor pomace; some soybean meal was used during the past year, but the total tonnage of vegetable meals used for fertilizer purposes

was less than in previous years, probably because more was not available. Tobacco growers are the chief consumers of organic nitrogenous fertilizers. Two samples of horn and hoof meal were analyzed.

Analyses of official samples of materials in this group are given in Table 1. Analyses of unofficial samples examined for purchasers are not tabulated.

II. Raw Materials Chiefly Valuable for Phosphoric Acid

Superphosphate formerly contained 16 per cent of available phosphoric acid, but in recent years so-called "double" and "triple" superphosphates have appeared that contain 20 per cent or more of available phosphoric acid. These products are made by treating rock phosphate with phosphoric acid instead of the sulphuric acid used in preparing the ordinary superphosphate.

All but two of the official samples analyzed this season were of the 20 per cent grade; one each was sold under a guaranty of 18 and 47 per cent. All samples met or exceeded their guaranties.

One sample of precipitated bone exceeded the guaranty of 38 per cent.

Analyses of official samples are given in Table 2.

III. Raw Materials Chiefly Valuable for Potash

Muriate of potash is the usual source of potash in mixed fertilizers in this State except for tobacco growing, where the presence of chloride is detrimental to the quality of the leaf. Only two official samples of muriate of potash were obtained this year; neither met its guaranty of 60 per cent potash (K_2O).

Three samples of sulphate of potash, one of sulphate of potash-magnesia and two of carbonate of potash substantially met their respective guaranties. No sales of carbonate of potash were reported during the 1944-1945 season; this year the tonnage nearly equalled that of the muriate.

Cottonhull ashes, because of their variable quality, are generally sold on a unit basis. Of two official samples, one was sold on a guaranty of 30 per cent potash (K_2O) but did not meet the guaranty.

Analyses of official samples are given in Table 3.

IV. Raw Materials Supplying Nitrogen and Phosphoric Acid

Dry ground fish and ground bone are the principal items in this group. Last year two samples of ground bone were found to contain ammonium sulphate and rock phosphate; similar adulteration was not encountered this year.

Analyses of official samples of dry ground fish and ground bone, as well as of "Milorganite", a treated sewage sludge, are given in Table 4.

V. Raw Materials Supplying Nitrogen and Potash

This year 160 tons of nitrate of potash were sold in the State. No sample of this salt was obtained by the Station agent. Pure potassium nitrate contains 13.7 per cent of nitrogen (N) and 46.6 per cent of potash (K_2O). The fertilizer grade should contain at least 12 per cent of nitrogen and 44 per cent of potash.

VI. Mixed Fertilizers

COMMERCIAL MIXTURES

Analyses of 129 official samples of mixed fertilizer are given in Table 5. Results are summarized as follows:

Total number of samples		129
Samples deficient in		
one item	18	
two items	4	22
Percentage of samples meeting guaranties		83
Total guaranties made		379[1]
Guaranties not met:		
nitrogen	12	
phosphoric acid	8	
potash	6	26
Percentage met		93

Ninety-three per cent of all guaranties made were substantially met or exceeded.

SPECIAL AND HOME MIXTURES

Seventy-nine samples of special and home mixtures were analyzed for tobacco growers during the year. Analyses are given in Table 6.

STATE PURCHASES OF FERTILIZER

Raw materials and mixed goods supplied to State institutions on State purchase orders are regularly included in our usual inspection. Fertilizers so supplied are subject to registration and tonnage tax.

Samples representing State purchases are indicated in the several tables. They are summarized as follows:

Materials	No. of samples	Reference
Supplying nitrogen	5	Table 1
Supplying phosphoric acid	3	Table 2
Supplying potash	2	Table 3
Supplying nitrogen and phosphoric acid	1	Table 4
Mixed fertilizers	11	Table 5
Total	22	

VII. Miscellaneous

Sheep manure. Fourteen official samples of sheep manure and other dried manures were analyzed. Analyses are given in Table 7.

Limestone and similar materials. No regular inspection of liming materials is made because our fertilizer law exempts "lime" from classification as commercial fertilizer. Twelve samples of limestone and agricultural lime were, however, analyzed for lime (CaO) and magnesia (MgO). Analyses are given in Table 8.

[1] Eight samples with only two guaranties.

Fertilizers sold in small packages. Registration is not required of those brands of fertilizer that are sold only in packages of less than 10 pounds. Because it was of interest to see how well these small package fertilizers met their guaranties, the Station agent sampled 16 brands during the past year, and analyses are given in Table 9. Of the 38 items guaranteed in 14 of these brands, there was only one deficiency (in phosphoric acid); 97 per cent of all guaranties were substantially met or exceeded.

Other miscellaneous materials. Twenty-four other miscellaneous products were examined. Analyses of 16 of them are given in Table 10.

Check meals and fertilizers. Collaboration was continued with the check analysis programs sponsored by the American Oil Chemists' Society and the F. S. Royster Guano Company. Many chemists from official and commercial laboratories and the laboratories of fertilizer manufacturers take part in these programs, which are valuable to us in providing a continued check on the accuracy of our analysts.

MAINTENANCE OF GUARANTIES

The maintenance of guaranties as compiled from analyses of official samples of ingredient materials and mixed goods, Tables 1 – 5 and 7, is shown in the following tabulation. Deficiencies of 0.1 per cent or less in nitrogen and of 0.2 per cent or less in phosphoric acid and potash are not considered. The proportion of guaranties substantially met was 92 per cent. Under any circumstances, this would be a very satisfactory record for the fertilizer industry, and it is particularly striking that it was attained under the difficult conditions of war times:

	No. of samples	No. of guaranties	Deficiencies
Nitrate of soda	3	3	0
Cyanamid	2	2	2
Urea	1	1	0
Nitrate of ammonia	2	2	0
Sulphate of ammonia	2	2	0
Castor pomace	5	5	0
Cottonseed meal	1	1	1
Horn and hoof meal	1	1	0
Superphosphate	13	13	0
Precipitated bone	1	1	0
Muriate of potash	2	2	2
Sulphate of potash	3	3	1
Sulphate of potash-magnesia	1	1	0
Cottonhull ashes	2	1	1
Carbonate of potash	2	2	0
Dry ground fish	4	8	0
Ground bone	9	18	2
Milorganite	1	1	0
Mixed fertilizer	129	379	26
Sheep manure	14	42	4
Totals	188	488	39
Per cent guaranties met			92

TABLE 1. ANALYSES OF MATERIALS SUPPLYING CHIEFLY NITROGEN

Station No.	Manufacturer or jobber	Sampled from stock of	Per cent nitrogen: Found	Per cent nitrogen: Guaranteed
	Nitrate of Soda			
5588	Chilean, Champion Brand. Chilean Nitrate Sales Corp., New York 5, N. Y.	New London: Eaton & Wilson Hardware Co.	16.06	16.00
5632[1]	Chilean, Champion Brand. Chilean Nitrate Sales Corp., New York 5, N. Y.	Cheshire: Conn. Reformatory	16.00	16.00
5702[1]	Chilean, Champion Brand. Chilean Nitrate Sales Corp., New York 5, N. Y.	Middletown: Conn. State Hospital	16.16	16.00
	Cyanamid			
5670[1]	20.6%, 'Aero' Granular. American Cyanamid Co., New York 20, N. Y.	Mansfield Depot: Mansfield Training School	19.88	20.60
5703[1]	20.6%, 'Aero' Granular. American Cyanamid Co., New York 20, N. Y.	Middletown: Conn. State Hospital	19.64	20.60
	Uramon Fertilizer Compound			
5805	E. I. du Pont de Nemours & Co., Inc., Wilmington 98, Del.	Bridgeport: Bridgeport Chemical Co.	43.40	42.00
	Fertilizer Compound Containing Ammonium Nitrate			
5701[1]	Nitraprills Fertilizer Compound Chemically Prepared. Ashcraft - Wilkinson Co., Atlanta, Ga.	Middletown: Long Lane Farm	33.17	32.50
5731	Nitraprills Fertilizer Compound Chemically Prepared. Ashcraft - Wilkinson Co., Atlanta, Ga.	New Haven: L. T. Frisbie Co.	33.33	33.50
	Sulphate of Ammonia			
5690	Apothecaries Hall Co., Waterbury, Conn.	East Windsor: Apothecaries Hall Co.	20.84	20.50
5704[1]	Apothecaries Hall Co., Waterbury, Conn.	Middletown: Conn. State Hospital	21.00	20.50
	Castor Pomace			
5838	Apothecaries Hall Co., Waterbury, Conn.	East Windsor: Apothecaries Hall Co.	5.84	4.50
5675	Spencer Kellogg & Sons, Inc., Buffalo, N. Y.	Brooklyn: Adelaid Laframboise	6.17	4.52

[1] State sample.

TABLE 1. ANALYSES OF MATERIALS SUPPLYING CHIEFLY NITROGEN—(*Concluded*)

Station No.	Manufacturer or jobber	Sampled from stock of	Per cent nitrogen: Found	Per cent nitrogen: Guaranteed
5828	O & W. Olds & Whipple, Inc., Hartford	Hartford: Olds & Whipple, Inc.	5.77	4.50
5835	The Rogers & Hubbard Co., Portland, Conn.	Portland: The Rogers & Hubbard Co.	6.24	4.50
5748	Woodruff's. The Woodruff Fertilizer Works, No. Haven, Conn.	No. Haven: The Woodruff Fertilizer Works	6.10	5.00
	Cottonseed Meal			
5778	"Lovit Brand", 41%. L. B. Lovitt & Co., Memphis, Tenn.	East Windsor: Apothecaries Hall Co.	6.43	6.56
	Horn and Hoof Meal			
5801	Old Deerfield. Old Deerfield Fertilizer Co., So. Deerfield, Mass.	Hazardville: L. B. Haas & Co.	14.31	14.00

TABLE 2. ANALYSES OF SUPERPHOSPHATE, ETC.

Station No.	Manufacturer or jobber	Sampled from stock of	Per cent phosphoric acid			
			Citrate-insoluble	Total	"Available"	
					Found	Guaranteed
	Superphosphate					
5589	18% Normal. The American Agricultural Chemical Co., No. Weymouth, Mass.	New London: New London Grain Co.	0.90	19.40	18.50	18.00
5580	20%. Apothecaries Hall Co., Waterbury, Conn.	Yalesville: The Barnes Bros. Nursery Co.	1.05	22.40	21.35	20.00
5680	Armour's Big Crop 20%. Armour Fertilizer Works, New York 5, N. Y.	East Windsor Hill: David Ahearn	0.95	21.70	20.75	20.00
5599	Corenco 20%. Consolidated Rendering Co., Boston 10, Mass.	New Haven: L. T. Frisbie Co.	0.50	22.05	21.55	20.00
5663	Davco Granulated 20%. Davison Chemical Corp., Baltimore, Md.	Bridgeport: The Berkshire Chemical Co.	0.58	21.35	20.77	20.00
5640	Eastern States Granulated and Pulverized 20%. Eastern States Farmers' Exchange, West Springfield, Mass.	East Hartford: Eastern States Farmers' Exchange	0.48	21.65	21.17	20.00
5643	O & W 20%. Olds & Whipple, Inc., Hartford, Conn.	East Hartford: Olds & Whipple, Inc.	0.18	21.80	21.62	20.00
5830	O & W Triple 47%. Olds & Whipple, Inc., Hartford, Conn.	East Hartford: Olds & Whipple, Inc.	0.38	48.50	48.12	47.00
5674	20%. The Rogers & Hubbard Co., Portland, Conn.	Mansfield Depot: G. Merritt Thompson	0.10	20.15	20.05	20.00
5802[1]	"Summers" 20%. Summers Fertilizer Co., Inc., Baltimore 2, Md.	Somers: Osborn Prison Farm	0.30	21.60	21.30	20.00
5710[1]	"Summers" 20%. Summers Fertilizer Co., Inc., Baltimore 2, Md.	Meriden: Conn. School for Boys	0.58	21.00	20.42	20.00
5669[1]	"Summers" 20%. Summers Fertilizer Co., Inc., Baltimore 2, Md.	Cheshire: Conn. Reformatory	0.05	20.25	20.20	20.00
5571	20%. I. P. Thomas & Son Co., Camden, N. J.	No. Haven: Joseph Beach	0.58	23.20	22.62	20.00
	Precipitated Bone					
5800	Apothecaries Hall Co., Waterbury, Conn.	Hazardville: L. B. Haas & Co.	0.05	40.60	40.55	38.00

[1] State purchase.

TABLE 3. ANALYSES OF POTASH SALTS, ETC.

Station No.	Manufacturer or jobber	Sampled from stock of	Per cent potash	
			Found	Guaranteed
	Muriate of Potash			
5594[1]	Apothecaries Hall Co., Waterbury, Conn.	Niantic: Farm for Women	59.60	60.00
5631[1]	Apothecaries Hall Co., Waterbury, Conn.	Cheshire: Conn. Reformatory	57.31	60.00
	Sulphate of Potash			
5839	Apothecaries Hall Co., Waterbury, Conn.	East Windsor: Apothecaries Hall	48.97	48.00
5831	O & W. Olds & Whipple, Inc., Hartford, Conn.	East Hartford: Olds & Whipple, Inc.	47.85	48.00
5788	Red-H, The Rogers & Hubbard Co., Portland, Conn.	Portland: The Rogers & Hubbard Co.	47.65	48.00
	Sulphate Potash-Magnesia			
5553	Old Deerfield Double. Old Deerfield Fertilizer Co., So. Deerfield, Mass.	Hazardville: L. B. Haas & Co., Inc.	21.70	21.50
	Cottonhull Ashes			
5777[2]	Apothecaries Hall Co., Waterbury, Conn.	East Windsor: Apothecaries Hall Co.	25.47	. . .
5833	O & W. Olds & Whipple, Inc., Hartford, Conn.	East Hartford: Olds & Whipple, Inc.	26.85	30.00
	Carbonate of Potash			
5775	Apothecaries Hall Co., Waterbury, Conn.	East Windsor: Apothecaries Hall Co.	64.01	64.00
5832	O & W. Olds & Whipple, Inc. Hartford, Conn.	East Hartford: Olds & Whipple, Inc.	66.67	65.00

[1] State sample.
[2] Sold on a unit basis.

TABLE 4. ANALYSES OF GROUND FISH, BONE, ETC.

Station No.	Manufacturer and brand	Sampled from stock of	Per cent nitrogen		Per cent phosphoric acid		Mechanical analysis (in percentage)	
			Total found	Total guaranteed	Total found	Total guaranteed	Finer than 1/50 inch	Coarser than 1/50 inch
	Dry Ground Fish							
5837[1]	Apothecaries Hall Co., Waterbury, Conn.	East Windsor: Apothecaries Hall Co.	9.78	9.00	7.55	5.00	....	....
5783[1]	Old Deerfield. Old Deerfield Fertilizer Co., Inc., So. Deerfield, Mass.	Glastonbury: E. J. Bantle	9.96	9.50	6.95	5.00	....	....
5554[2]	O & W Menhaden. Olds & Whipple, Inc., Hartford, Conn.	Hazardville: L. B. Haas & Co.	10.26	9.00	6.65	5.00	....	....
5793[3]	Hubbard. The Rogers & Hubbard Co., Portland, Conn.	Portland: The Rogers & Hubbard Co.	10.00	9.56	6.75	5.00	....	....
	Ground Bone							
5592	Apothecaries Hall Co., Waterbury, Conn.	New London: New London Grain Co.	2.72	2.25	25.70	22.00	49.0	51.0
5772	Armour's. Armour Fertilizer Works, New York 5, N. Y.	East Windsor Hill: David Ahearn	2.70	2.47	26.50	23.00	62.0	38.0
5565	Corenco. Consolidated Rendering Co., Boston 10, Mass.	Thompsonville: Brainard Nursery & Seed Co.	2.84	2.47	25.90	23.00	57.0	43.0
5799	Corenco. Consolidated Rendering Co., Boston 10, Mass.	Manchester: C. R. Burr & Co.	4.25	2.47	20.50	23.00	22.0	78.0
5798	O & W. Olds & Whipple, Inc., Hartford, Conn.	Bloomfield: Bloomfield Farmers' Exchange	3.29	2.47	26.50	22.00	34.0	66.0
5708	Gro-Fast. The Rogers & Hubbard Co., Portland, Conn.	Meriden: Raven Hardware Co.	2.80[4]	2.00	26.25	23.00	63.0	37.0
5787[5]	Gro-Fast. The Rogers & Hubbard Co., Portland, Conn.	Meriden: Undercliff Sanatorium	2.63[6]	2.00	27.10	23.00	70.0	30.0
5792	Hubbard Raw Knuckle Bone Flour. The Rogers & Hubbard Co., Portland, Conn.	Portland: The Rogers & Hubbard Co.	4.50	4.00	24.90	23.00	57.9	40.3
5629	Sawco. Stumpp & Walter Co., New York 8, N. Y.	Stamford: Stumpp & Walter Co.	2.28	2.47	25.55	24.00	50.0	50.0
	Milorganite							
5754	Sewerage Commission of the City of Milwaukee, Milwaukee, Wis.	Darien: Ring's End Fuel Co., Inc.	6.00[7]	6.00	3.90[8]	2.75	....	....

[1] Chlorine 0.40%.
[2] Chlorine 0.42%.
[3] Chlorine 0.34%.
[4] Nitrogen in ammonia 0.68%.
[5] State sample.
[6] Nitrogen in ammonia 0.52%.
[7] Found: nitrogen in nitrates 0.00; nitrogen in ammonia 0.12%; nitrogen organic water-soluble 0.49%; nitrogen organic insoluble 5.39%.
[8] Guaranteed "available" phosphoric acid 2.00%.

TABLE 5. ANALYSES OF MIXED FERTILIZERS

Station No.	Manufacturer and brand	Place of sampling	Per cent nitrogen: In nitrates	In ammonia	Organic water-soluble	Organic water-insoluble	Total	Per cent phosphoric acid: Citrate-insoluble	Total	So-called "available"	Per cent potash: As muriate	Total	Station No.
	The Acme Guano Co., Baltimore, Md.												
5648	Acme 5–8–7	Suffield	0.46	4.00	0.48	0.15	5.09	0.40	8.75	8.35	7.33	7.33	5648
5705	Acme 5–10–5	Middletown	0.00	4.72	0.20	0.27	5.19	0.85	11.50	10.65	4.85	4.85	5705
5862	Acme 7–7–7	Suffield	0.00	6.00	0.47	0.19	6.66	0.53	7.58	7.05	6.97	7.54	5862
	Agricultural Supply Co., West Haven, Conn.												
5601	Yale Special Mixture 8–6–2	New Haven	0.00	5.20	2.65	0.41	8.26	0.58	6.98	6.40	2.40	2.40	5601
	American Agricultural Chemical Co., No. Weymouth 91, Mass.												
5694	AA Quality Fertilizer 5–8–7	East Hartford	0.47	4.10	0.14	0.27	4.98	1.73	10.75	9.02	7.40	7.40	5694
5693	AA Quality Fertilizer 5–10–10	East Hartford	0.63	4.20	0.14	0.10	5.07	0.85	11.28	10.43	9.57	10.06	5693
5734	Agrico for Corn 3–12–6	West Haven	0.00	2.90	0.21	0.15	3.26	1.20	13.70	12.50	6.32	6.32	5734
5602	Agrico for Corn 4–12–8	West Haven	0.61	3.12	0.22	0.12	4.07	0.58	13.55	12.97	7.97	8.00	5602
5603	Agrico Country Club Fertilizer 6–10–4	West Haven	0.36	5.22	0.10	0.26	5.94	0.68	11.35	10.67	4.59	4.59	5603
5576	Agrico for Gardens 4–12–4	Wallingford	0.74	3.00	0.16	0.32	4.22	1.05	13.50	12.45	4.04	4.17	5576
5606	Agrico for Gardens 5–10–5	Milford	0.55	4.40	0.06	0.17	5.18	0.80	10.98	10.18	5.35	5.35	5606
5578	Agrico for Lawns, Trees and Shrubs 4–12–4	Wallingford	0.40	3.32	0.22	0.19	4.13	1.20	13.05	11.85	4.13	4.13	5578
5735	Agrico for New England 4–10–10	West Haven	0.66	3.14	0.10	0.10	4.00	0.78	10.90	10.12	9.98	9.98	5735
5582	Agrico for New England 5–8–7	Groton	0.52	4.24	0.10	0.22	5.08	1.05	9.40	8.35	7.00	7.00	5582
5575	Agrico for Potatoes 5–10–10	Wallingford	0.54	4.00	0.24	0.16	4.94	1.03	11.13	10.10	10.07	10.14	5575
5732	Agrico for Seeding Down 4–12–16	West Haven	0.40	2.92	0.58	0.08	3.98	0.98	12.90	11.92	15.90	15.90	5732
5692	Agrico for Tobacco 6–3–6	East Hartford	0.00	0.62	2.56	2.56	5.74	0.63	4.73	4.10	1.38	7.00	5692
5676	Agrico for Top Dressing 7–7–7	Putnam	0.27	6.28	0.30	0.21	7.06	0.90	8.43	7.53	6.90	6.90	5676
5604	Agrico Phosphate and Potash 0–14–14	West Haven	...	...	...	...	...	1.08	15.53	14.45	13.86	13.86	5604
	Apothecaries Hall Co., Waterbury, Conn.												
5687	Liberty Fertilizer 4–12–4	East Windsor	0.59	3.12	0.16	0.49	4.36	0.48	13.38	12.90	4.29	4.63	5687
5689	Liberty Fertilizer 5–10–5	East Windsor	0.14	4.14	0.56	0.62	5.46	0.23	11.73	11.50	5.72	5.72	5689
5591	Liberty Fertilizer 5–10–10	New London	0.73	3.82	0.08	0.56	5.19	0.70	11.63	10.93	9.32	9.98	5591
5685	Liberty Fertilizer with Sulphate Potash 5–10–10	East Windsor	0.16	4.16	0.68	0.40	5.40	0.20	11.05	10.85	1.05	10.77	5685
5581	Liberty Fertilizer Special for Fruit and Grass 7–7–7	Yalesville	0.42	5.48	0.16	1.00	7.06	0.50	8.48	7.98	7.34	7.34	5581
5627	Liberty Green Gro Fertilizer 6–7–4	Stamford	0.00	4.80	0.65	1.12	6.57	0.23	7.68	7.45	4.75	4.75	5627
5611	Liberty High Grade Market Gardeners 5–8–7	Greenwich	0.00	4.14	0.63	0.57	5.34	0.40	8.73	8.33	2.27	8.14	5611
5794[1]	Liberty High Grade Market Gardeners 5–8–7	Portland	0.58	4.00	0.20	0.75	5.53	0.45	9.83	9.38	7.99	7.99	5794
5684	Liberty High Grade Market Gardeners with Sulphate of Potash 5–8–7	East Windsor	0.00	4.56	0.40	0.14	5.10	0.73	8.80	8.07	0.77	7.03	5684
5586	Liberty Home Garden Fertilizer 5–10–5	New London	0.80	3.92	0.00	0.63	5.35	0.35	11.30	10.95	5.60	5.60	5586
5860	Liberty Tobacco Mixture 5–3–5	East Windsor	0.74	1.00	0.40	2.55	4.69	0.15	3.38	3.23	0.54	6.01	5860
5776	Liberty Tobacco Mixture 6–3–6	East Windsor	1.43	0.10	2.10	2.65	6.28	0.23	4.18	3.95	0.35	7.05	5776
5774	Liberty Tobacco Mixture with Cotton Hull Ashes 6–3–6	East Windsor	1.07	0.04	2.48	2.71	6.30	0.23	4.33	4.10	0.48	6.61	5774
5688	Liberty Tobacco Starter Fertilizer 4–10–0	East Windsor	1.03	2.38	0.04	0.81	4.26	0.83	11.80	10.97	...	...	5688
	Armour Fertilizer Works, New York 5, N. Y.												
5682	Armour's Big Crop Fertilizer 4–12–4	East Windsor Hill	0.20	3.00	0.58	0.44	4.22	1.23	13.68	12.45	4.25	4.25	5682
5679	Armour's Big Crop Fertilizer 5–8–7	East Windsor Hill	0.59	3.88	0.48	0.26	5.21	2.18	11.10	8.92	7.07	7.07	5679

[1] State purchase.

CONTAINING NITROGEN, PHOSPHORIC ACID AND POTASH

TABLE 5. ANALYSIS OF MIXED FERTILIZERS

CONTAINING NITROGEN, PHOSPHORIC ACID AND POTASH

Station No.	Manufacturer and brand	Place of sampling	Per cent nitrogen: In nitrates	In ammonia	Organic water-soluble	Organic water-insoluble	Total	Per cent phosphoric acid: Citrate-insoluble	Total	So-called "available"	Per cent potash: As muriate	Total	Station No.
5681	Armour's Big Crop Fertilizer 5–10–10	East Windsor Hill	0.76	4.10	0.46	0.24	5.56	0.48	11.48	11.00	10.00	10.00	5681
5771	Armour's Big Crop Tobacco Special 5–3–5	East Windsor Hill	0.30	0.54	1.46	3.32	5.62	0.33	4.30	3.97	1.33	6.81	5771
5770	Armour's Big Crop Tobacco Special 6–3–6	East Windsor Hill	0.40	0.64	1.64	3.34	6.02	0.25	4.05	3.80	1.30	6.74	5770
5683	Armour's Special Ornamental Fertilizer 6–12–4	East Windsor Hill	0.47	3.72	0.10	0.25	4.54	0.73	15.53	14.80	3.31	3.31	5683
	Associated Seed Growers, Inc., Milford, Conn.												
5609	Asgrow Lawn Food 10–6–4	Milford	0.23	1.48	8.00	0.47	10.18	0.30	6.10	5.80	5.15	5.15	5609
	The F. A. Bartlett Tree Expert Co., Stamford, Conn.												
5753	Bartlett Green Tree Food 6–8–6	Stamford	0.72	3.08	1.56	0.45	5.81	0.28	8.45	8.17	5.53	6.72	5753
	The Berkshire Chemical Co., Bridgeport, Conn.												
5660	Berkshire Fertilizer 0–14–14	Bridgeport	...	...	...	...	...	0.60	14.65	14.05	14.32	14.32	5660
5662	Berkshire Fertilizer 4–12–4	Bridgeport	0.47	3.48	0.06	0.21	4.22	0.40	13.43	13.03	4.73	5.24	5662
5598	Berkshire Fertilizer 5–8–7	Guilford	0.53	4.52	0.06	0.11	5.22	0.35	8.83	8.48	6.96	7.21	5598
5698[1]	Berkshire Fertilizer 5–8–7	Middletown	0.36	4.64	0.00	0.13	5.13	0.40	8.58	8.18	7.29	7.29	5698
5803	Berkshire Fertilizer 5–10–5	Bridgeport	0.75	3.90	0.22	0.13	5.00	0.45	11.00	10.55	5.14	5.14	5803
5597	Berkshire Fertilizer 5–10–10	Guilford	0.49	4.54	0.06	0.13	5.22	0.35	11.23	10.88	10.07	10.08	5597
5661	Berkshire Fertilizer 7–7–7	Bridgeport	0.41	6.36	0.08	0.11	6.96	0.25	8.18	7.93	7.09	7.09	5661
5804	Berkshire Tobacco Fertilizer 6–3–6	Bridgeport	0.76	0.04	2.52	2.80	6.12	0.15	4.10	3.95	0.70	6.05	5804
	Consolidated Rendering Co., Boston 10, Mass.												
5600	Corenco 0–14–14 Top Dresser	New Haven	...	...	...	...	...	0.53	14.55	14.02	14.29	15.37	5600
5552	Corenco 4–12–4 Complete Manure	New Haven	0.00	2.64	0.98	0.18	3.80	0.60	12.98	12.38	4.37	4.50	5552
5878	Corenco 4–12–4 Complete Manure	New Haven	0.00	3.64	0.54	0.16	4.34	0.68	12.18	11.50	4.49	5.25	5878
5551	Corenco 5–8–7 Potato and General Crop	New Haven	0.00	3.68	1.34	0.12	5.14	0.48	8.58	8.10	6.99	7.15	5551
5568	Corenco 5–10–5 Home Garden Fertilizer	New Haven	0.00	3.70	1.23	0.15	5.08	0.73	11.13	10.40	0.51	5.46	5568
5556	Corenco 5–10–10 Peerless Potato	Thompsonville	0.00	3.94	1.11	0.10	5.15	0.63	10.67	10.04	9.45	10.78	5556
5730	Corenco 6–3–6 Special Tobacco Grower	New Haven	0.00	0.40	2.78	3.27	6.45	0.18	4.83	4.65	0.31	5.32	5730
5547	Corenco 7–7–7 Complete Fruit and Top Dressing	New Haven	0.48	6.16	0.32	0.09	7.05	0.45	7.53	7.08	6.71	7.02	5547
5546	Corenco 8–6–4 Landscape Fertilizer	New Haven	0.00	5.24	2.68	0.49	8.41	0.45	7.15	6.70	4.21	4.21	5546
	The Davey Tree Expert Co., Kent, Ohio												
5625	Davey Tree Food 12–4–4	Old Greenwich	1.22	9.86	0.36	0.69	12.13	0.33	5.95	5.62	3.74	3.74	5625
	Davison Chemical Corp., Baltimore, Md.												
5806	Davco Granulated Fertilizer 5–10–10	Wilson	0.36	4.46	0.18	0.12	5.12	0.40	10.23	9.83	10.54	10.54	5806
	Eastern States Farmers' Exchange, West Springfield, Mass.												
5573	Eastern States 5–10–5 V G	No. Haven	0.71	3.96	0.22	0.21	5.10	0.40	11.13	10.73	5.76	5.76	5573
5572	Eastern States 5–10–10	No. Haven	0.83	4.04	0.22	0.25	5.34	0.90	10.98	10.08	10.33	10.33	5572
5642	Eastern States 5–15–5	East Hartford	0.86	2.12	2.16	0.30	5.44	0.73	15.85	15.12	5.22	5.22	5642
5786	Eastern States 8–4–8	Melrose	0.00	0.52	4.64	2.51	7.67	0.28	5.00	4.72	1.24	9.24	5786
5784	Eastern States 8–16–16	Broad Brook	1.49	6.06	0.30	0.23	8.08	0.28	16.55	16.27	16.39	17.25	5784
5641	Eastern States 8–24–8	East Hartford	1.35	6.34	0.12	0.37	8.18	0.40	24.60	24.20	9.54	9.54	5641
5785	Eastern States 10–10–10	Melrose	1.94	7.44	0.20	0.42	10.00	0.28	10.50	10.22	10.64	10.64	5785

[1] State purchase.

TABLE 5. ANALYSIS OF MIXED FERTILIZERS

CONTAINING NITROGEN, PHOSPHORIC ACID AND POTASH

Station No.	Manufacturer and brand	Place of sampling	Per cent nitrogen: In nitrates	In ammonia	Organic water-soluble	Organic water-insoluble	Total	Per cent phosphoric acid: Citrate-insoluble	Total	So-called "available"	Per cent potash: As muriate	Total	Station No.
	McCormick & Co., Inc. Baltimore 2, Md.												
5857	Hy-Gro 13–26–13	New Haven	1.98	6.50	6.78	0.07	15.33	0.13	31.05	30.92	8.32	12.85	5857
	Miller Chemical & Fertilizer Corp., Baltimore 31, Md.												
5861	VHPF 5–25–15	Warehouse Point	3.71	1.26	0.14	0.00	5.11	0.03	30.00	29.97	14.90	14.90	5861
	Old Deerfield Fertilizer Co., Inc., South Deerfield, Mass.												
5863	Old Deerfield 5–5–15 Tobacco	West Suffield	1.08	0.62	3.28	0.54	5.52	0.28	6.43	6.15	1.22	16.67	5863
5773	Old Deerfield 6–3–6 Complete Tobacco Fertilizer	Broad Brook	0.62	0.52	1.60	3.61	6.35	0.23	4.58	4.35	0.70	6.34	5773
	Olds & Whipple, Inc., Hartford, Conn.												
5797	O & W 4–8–4 Complete Lawn Grass Fertilizer	Bloomfield	0.38	2.68	0.72	0.58	4.36	0.68	9.60	8.92	4.21	4.65	5797
5645	O & W 4–12–4 Market Garden Fertilizer	East Hartford	0.00	3.36	0.53	0.50	4.39	0.55	12.88	12.33	5.24	5.24	5645
5826	O & W 5–3–5 Complete Tobacco Fertilizer Potash derived from Cotton Hull Ashes	East Hartford	1.19	0.12	2.08	2.23	5.62	0.33	4.03	3.70	0.40	5.39	5826
5859	O & W 5–3–5 Complete Tobacco Fertilizer	East Hartford	0.98	0.76	1.20	2.34	5.28	0.23	3.68	3.45	0.51	5.48	5859
5807	O & W 5–5–15 High Grade Tobacco Starter and Potash	East Hartford	2.61	0.00	0.68	1.99	5.28	0.43	6.03	5.60	0.65	16.05	5807
5808	Luxura 5–8–6	East Hartford	0.00	2.20	1.38	2.12	5.70	1.35	12.45	11.10	5.50	6.28	5808
5796	O & W 5–8–7 Potato and General Purpose Fertilizer	Bloomfield	0.00	4.56	0.37	0.39	5.32	0.28	8.90	8.62	7.50	7.50	5796
5825	O & W 5–8–7 Potato and General Purpose Fertilizer with Sulphate Potash	East Hartford	0.00	4.44	0.33	0.63	5.40	0.33	8.43	8.10	0.70	7.03	5825
5593[1]	O & W 5–10–5 Fertilizer	Niantic	0.28	2.84	1.76	0.47	5.35	0.53	10.98	10.45	4.97	5.67	5593
5633[1]	O & W 5–10–5 Fertilizer	Cheshire	0.22	3.90	0.82	0.49	5.43	0.43	11.00	10.57	5.61	6.09	5633
5595[1]	O & W 5–10–10 Potato Fertilizer	Niantic	0.57	3.96	0.28	0.64	5.45	0.43	11.10	10.67	9.82	10.06	5595
5638[1]	O & W 5–10–10 Potato Fertilizer	Cheshire	0.54	4.14	0.14	0.56	5.38	0.25	11.35	11.10	10.10	10.10	5638
5829	O & W 6–3–6 Blue Label Tobacco Fertilizer	East Hartford	1.27	0.18	2.20	2.71	6.36	0.33	3.83	3.50	0.56	6.06	5829
5858	O & W 6–3–6 Blue Label Tobacco Fertlizer Potash derived from Cotton Hull Ashes	East Hartford	1.51	0.18	2.26	2.07	6.02	0.33	4.13	3.80	0.65	6.84	5858
5827	O & W 7–7–7 Top Dressing and Grass Fertilizer	East Hartford	0.48	5.70	0.38	0.52	7.08	0.23	7.45	7.22	7.03	7.03	5827
	The Frank S. Platt Co., New Haven 10, Conn.												
5555	Platt's Special 10–5–5 Lawn Dressing	New Haven	0.20	6.28	2.46	1.20	10.14	0.45	5.88	5.43	4.77	5.00	5555
	Ralston Purina Co., St. Louis, Mo.												
5678	Purina Plant Food 5–10–5	Putnam	0.58	4.20	0.08	0.17	5.03	0.43	11.33	10.90	3.59	5.43	5678
	The Rogers & Hubbard Co., Portland, Conn.												
5549	Gro-Fast Plant Food 5–8–5	New Haven	0.38	3.28	0.78	1.06	5.50	0.40	9.03	8.63	5.53	5.59	5549
5709	Gro-Fast Plant Food 5–8–5	Meriden	0.42	2.86	0.80	1.24	5.42	0.28	9.43	9.15	5.41	5.41	5709
5696	Hubbard High Potash Fertilizer 5–10–10	Portland	0.52	3.12	0.70	1.46	5.80	0.48	10.83	10.35	10.16	10.16	5696
5585	Hubbard Potato Fertilizer 5–8–7	New London	1.31	3.12	0.63	0.47	5.53	0.25	8.80	8.55	8.04	8.04	5585
5834	Hubbard Tobacco Grower 6–3–6	Portland	1.30	0.18	3.32	2.50	7.30	0.20	3.93	3.73	0.68	6.92	5834

[1] State purchase.

TABLE 5 ANALYSIS OF MIXED FERTILIZERS

Station No.	Manufacturer and brand	Place of sampling	Per cent nitrogen: In nitrates	In ammonia	Organic water-soluble	Organic water-insoluble	Total	Per cent phosphoric acid: Citrate-insoluble	Total	So-called "available"	Per cent potash: As muriate	Total	Station No.
5697	Red–H 0–14–14	Portland	...	...	...	...	...	0.40	13.95	13.55	12.52	12.52	5697
5942	Red–H 0–14–14	Norwich	...	...	...	...	...	0.10	14.75	14.65	13.44	13.97	5942
5707	Red–H 4–12–4	Meriden	0.69	3.08	0.04	0.53	4.34	0.88	13.08	12.20	4.26	4.26	5707
5695	Red–H 4–12–8	Portland	0.82	3.40	0.16	0.40	4.78	0.85	13.20	12.35	9.22	9.22	5695
5584	Red–H 5–8–7	New London	0.86	4.00	0.12	0.55	5.53	0.43	8.93	8.50	7.44	7.44	5584
5789	Red–H 5–10–5	Portland	1.08	3.88	0.24	0.50	5.70	0.43	11.18	10.75	5.72	5.72	5789
5671	Red–H 5–10–10	Mansfield Depot	1.10	3.68	0.40	0.18	5.36	0.38	10.85	10.47	10.08	10.08	5671
5677	Red–H 7–7–7	Putnam	0.48	6.04	0.24	0.40	7.16	0.15	8.15	8.00	7.37	7.37	5677
5791	Red–H 8–16–16	Portland	0.62	6.28	0.44	0.39	7.73	0.23	15.30	15.07	16.10	16.10	5791
5790	Victory Garden Fertilizer 5–10–5	Portland	0.91	4.00	0.08	0.42	5.41	0.53	11.40	10.87	5.50	5.50	5790
	O. M. Scott & Sons Co., Marysville, Ohio												
5579	Scott's Turf Builder 8–8–4	Yalesville	0.30	5.54	0.20	1.47	7.51	0.60	9.25	8.65	4.07	4.07	5579
	M. L. Shoemaker, Division of Wilson & Co., Inc., Philadelphia, Pa.												
5567	M. L. Shoemaker's "Swift-Sure" 4–10–0	Suffield	0.66	2.90	0.12	0.64	4.32	0.93	12.88	11.95	...	...	5567
	Stumpp & Walter Co., New York 8, N. Y.												
5628	Sawco General Garden Fertilizer 5–10–5	Stamford	0.40	4.78	0.08	0.45	5.71	0.18	9.33	9.15	7.12	8.64	5628
	Summers Fertilizer Co., Inc., Baltimore 2, Md.												
5664[1]	"Summers" 0–20–20 Fertilizer	Southbury	...	...	...	...	...	0.58	19.95	19.37	17.79	20.01	5664
5668[1]	"Summers" 0–20–20 Fertilizer	Cheshire	...	...	...	...	...	0.30	17.75	17.45	16.83	16.83	5668
5665[1]	"Summers" 5–10–10 Fertilizer	Southbury	0.79	3.82	0.28	0.22	5.11	0.60	11.15	10.55	10.79	11.44	5665
5596[1]	"Summers" 8–16–16 Fertilizer	Niantic	0.31	7.22	0.78	0.05	8.36	0.10	12.90	12.80	15.91	16.25	5596
5667[1]	"Summers" 10–10–10 Fertilizer	Cheshire	4.76	4.98	0.08	0.06	9.88	0.15	10.83	10.68	10.64	10.64	5667
5729[1]	"Summers" 10–10–10 Fertilizer	Meriden	3.62	3.82	0.14	0.10	7.68	0.38	11.63	11.25	11.24	11.24	5729
	Swift & Co., Plant Food Div., Baltimore, Md.												
5613	Swift's Red Steer 5–8–7	Greenwich	0.24	4.50	0.18	0.19	5.11	0.48	9.20	8.72	7.21	7.21	5613
5624	Swift's Red Steer 5–10–10	Cos Cob	0.13	4.44	0.04	0.39	5.00	0.53	10.90	10.37	9.96	9.96	5624
5548	Vigoro 4–12–4	New Haven	0.31	3.30	0.14	0.29	4.04	0.40	12.93	12.53	3.58	4.05	5548
	Stewart H. Willson, Thompsonville, Conn.												
5691	Willson's Old Enfield Tree Food 6–7–4	East Windsor	0.00	5.26	0.48	0.68	6.42	0.60	8.25	7.65	4.48	4.48	5691
	Tennessee Corp., Lockland, Ohio												
5856	Loma 5–10–5	Greenwich	0.25	4.04	0.42	0.27	4.98	0.23	10.12	9.89	5.13	5.78	5856
	I. P. Thomas & Son Co., Camden, N. J.												
5569	I. P. Thomas 5–8–7	No. Haven	0.65	3.78	0.08	0.32	4.83	0.60	9.85	9.25	7.87	7.87	5569
5666	I. P. Thomas 5–10–10	Hamden	0.57	4.14	0.30	0.32	5.33	0.58	10.73	10.15	10.67	10.67	5666

[1] State purchase.

CONTAINING NITROGEN, PHOSPHORIC ACID AND POTASH

TABLE 5. ANALYSIS OF MIXED FERTILIZERS

Station No.	Manufacturer and brand	Place of sampling
5570	I. P. Thomas 7–7–7	No. Haven
	F. H. Woodruff & Sons, Inc., Milford, Conn.	
5607	Gro-Sod Lawn Food 10–6–4	Milford
	The Woodruff Fertilizer Works, Inc. No. Haven, Conn.	
5608	Clark's Tip-Top 5–8–7 Fertilizer	Milford
5747	Woodruff's 4–12–4 Fertilizer	No. Haven
5746	Woodruff's 5–8–7 Fertilizer	No. Haven
5739	Woodruff's 5–10–5 Fertilizer	No. Haven
5740	Woodruff's 5–10–10 Fertilizer	No. Haven
5738	Woodruff's 6–3–6 Tobacco Fertilizer	No. Haven
5737	Woodruff's 7–7–7 Fertilizer	No. Haven
5736	Woodruff's Lawn Fertilizer 10–6–4	No. Haven

CONTAINING NITROGEN, PHOSPHORIC ACID AND POTASH

Per cent nitrogen					Per cent phosphoric acid			Per cent potash		Station No.
In nitrates	In ammonia	Organic water-soluble	Organic water-insoluble	Total	Citrate-insoluble	Total	So-called "available"	As muriate	Total	
0.49	5.36	0.26	0.23	6.34	0.65	9.70	9.05	7.97	8.08	5570
0.00	5.48	2.78	1.81	10.07	0.65	6.87	6.22	3.95	3.95	5607
0.00	4.74	0.13	0.59	5.46	0.68	9.40	8.72	7.07	7.07	5608
0.45	2.56	0.64	0.56	4.21	1.03	13.20	12.17	4.31	4.83	5747
0.00	3.64	0.75	0.75	5.14	1.05	9.18	8.13	6.23	6.90	5746
0.45	3.20	0.96	0.70	5.31	1.40	11.18	9.78	5.43	5.43	5739
0.00	2.76	1.59	0.65	5.00	0.65	10.78	10.13	9.73	9.73	5740
2.10	0.00	1.60	2.37	6.07	0.23	3.70	3.47	0.51	6.10	5738
0.11	1.20	5.44	0.75	7.50	0.55	7.55	7.00	7.17	7.17	5737
0.17	0.90	7.38	1.80	10.25	0.33	6.40	6.07	4.78	5.43	5736

TABLE 6. ANALYSES OF SPECIAL AND HOME MIXTURES

Station No.	Name of mixture	Sampled or submitted by	Total nitrogen percent	Per cent phosphoric acid			Per cent potash			Station No.
				Citrate-insoluble	Total	So-called "available"	As muriate	Total	Chlorine	
5231	Fertilizer 1946 Formula, G	Hartford: Consolidated Cigar Corp.	5.86	0.23	4.13	3.90	0.51	8.69	0.38	5231
5232	Fertilizer 1946 Formula, Hu	Hartford: Consolidated Cigar Corp.	5.86	0.30	4.43	4.13	0.45	7.15	0.34	5232
5545	Fertilizer Formula SA–1946	Hartford: Consolidated Cigar Corp.	5.03	0.33	4.03	3.70	0.70	8.88	0.53	5545
5814	Home Mixture R H 1946 Formula, Bis	Hartford: Consolidated Cigar Corp.	7.06	0.18	2.85	2.67	1.10	7.21	0.83	5814
5819	1946 O D Formula, 72 Tons, Lev	Hartford: Consolidated Cigar Corp.	5.08	0.18	4.68	4.50	0.54	8.24	0.41	5819
5823	1946 O D Formula, 100 Tons, Bis	Hartford: Consolidated Cigar Corp.	7.06	0.25	4.00	3.75	0.54	5.97	0.41	5823
4657	Home Mixed Fertilizer – Formula 4–2–45	Simsbury: Cullman Bros., Inc.	5.03	0.27	5.72	5.45	0.54	4.71	0.41	4657
4658	Home Mixed Fertilizer 4–3–45	Simsbury: Cullman Bros., Inc.	4.91	0.29	6.01	5.72	0.57	4.07	0.43	4658
4659	Home Mixed Fertilizer 4–4–45	Simsbury: Cullman Bros., Inc.	5.15	0.24	5.67	5.43	0.51	4.05	0.38	4659
4660	Home Mixed Fertilizer 4–5–45	Simsbury: Cullman Bros., Inc.	4.92	0.18	6.07	5.89	0.49	4.51	0.37	4660
4661	Home Mixed Fertilizer 4–6–45	Simsbury: Cullman Bros., Inc.	5.18	0.20	5.53	5.33	0.58	4.26	0.44	4661
4662	Home Mixed Fertilizer 4–7–45	Simsbury: Cullman Bros., Inc.	5.30	0.20	5.57	5.37	0.65	4.50	0.49	4662
4663	Home Mixed Fertilizer 4–8–45	Simsbury: Cullman Bros., Inc.	5.32	0.25	5.29	5.04	0.62	4.54	0.47	4663
4681	Home Mixed Fertilizer 5–1–45	Simsbury: Cullman Bros., Inc.	5.25	0.45	4.65	4.20	0.43	5.04	0.32	4681
4682	Home Mixed Fertilizer 5–2–45	Simsbury: Cullman Bros., Inc.	5.06	0.30	5.45	5.15	0.58	6.57	0.44	4682
4683	Home Mixed Fertilizer 5–3–45	Simsbury: Cullman Bros., Inc.	5.39	0.35	4.66	4.31	0.69	6.40	0.52	4683
4684	Home Mixed Fertilizer 5–4–45	Simsbury: Cullman Bros., Inc.	5.42	0.32	4.64	4.32	0.68	6.60	0.51	4684
4685	Home Mixed Fertilizer 5–5–45	Simsbury: Cullman Bros., Inc.	5.34	0.34	4.45	4.11	0.62	6.29	0.47	4685
4686	Home Mixed Fertilizer 5–6–45	Simsbury: Cullman Bros., Inc.	4.94	0.51	5.59	5.08	0.70	6.65	0.53	4686
4687	Home Mixed Fertilizer 5–7–45	Simsbury: Cullman Bros., Inc.	5.08	0.45	5.36	4.91	0.61	5.95	0.46	4687
4688	Home Mixed Fertilizer 5–8–45	Simsbury: Cullman Bros., Inc.	5.03	0.40	5.35	4.95	0.65	6.82	0.49	4688
4703	Home Mixed Fertilizer 7–S–K–45	Simsbury: Cullman Bros., Inc.	4.82	0.31	6.50	6.19	0.40	6.36	0.30	4703
4704	Home Mixed Fertilizer 7–N–K–45	Simsbury: Cullman Bros., Inc.	4.82	0.35	6.41	6.06	0.47	6.59	0.35	4704
4705	Home Mixed Fertilizer 7–H–4–45	Simsbury: Cullman Bros., Inc.	4.32	0.45	5.99	5.54	0.62	5.80	0.47	4705
4706	Home Mixed Fertilizer 7–H–5–45	Simsbury: Cullman Bros., Inc.	4.54	0.54	6.31	5.77	0.53	6.36	0.40	4706
4707	Home Mixed Fertilizer 7–H–2–45	Simsbury: Cullman Bros., Inc.	4.52	0.63	6.33	5.70	0.56	5.93	0.42	4707

TABLE 6. ANALYSES OF SPECIAL AND HOME MIXTURES—(*Continued*)

Station No.	Name of mixture	Sampled or submitted by	Total nitrogen percentage	Per cent phosphoric acid			Per cent potash			Station No.
				Citrate-insoluble	Total	So-called "available"	As muriate	Total	Chlorine	
4708	Home Mixed Fertilizer 7–H–1–45	Simsbury: Cullman Bros., Inc.	4.13	0.59	6.70	6.11	0.62	6.32	0.47	4708
4780	Home Mixed Fertilizer 6–C–1–46	Simsbury: Cullman Bros., Inc.	4.74	0.61	4.55	3.94	0.54	4.56	0.41	4780
4781	Home Mixed Fertilizer 6–C–2A–46	Simsbury: Cullman Bros., Inc.	5.03	0.74	5.31	4.57	0.56	6.50	0.42	4781
4782	Home Mixed Fertilizer 6–2–46	Simsbury: Cullman Bros., Inc.	5.00	0.77	5.35	4.58	0.58	5.54	0.44	4782
4783	Home Mixed Fertilizer 6–3–W–46	Simsbury: Cullman Bros., Inc.	5.31	0.54	5.30	4.76	0.51	5.35	0.39	4783
4832	Home Mixed Fertilizer 3–B–L–46	Simsbury: Cullman Bros., Inc.	5.50	0.30	4.66	4.36	0.29	5.54	0.22	4832
4833	Home Mixed Fertilizer 3–C–13–46	Simsbury: Cullman Bros., Inc.	5.60	0.49	5.70	5.21	0.27	5.37	0.20	4833
4834	Home Mixed Fertilizer 3–H–1–46	Simsbury: Cullman Bros., Inc.	5.62	0.42	5.78	5.36	0.29	5.16	0.22	4834
4838	Home Mixed Fertilizer 3–H–3–46	Simsbury: Cullman Bros., Inc.	4.89	0.68	6.01	5.33	0.49	6.36	0.37	4838
4839	Home Mixed Fertilizer 3–L–11–46	Simsbury: Cullman Bros., Inc.	5.32	0.46	5.20	4.74	0.56	6.98	0.42	4839
4840	Home Mixed Fertilizer 3–L–12–46	Simsbury: Cullman Bros., Inc.	5.54	0.37	5.55	5.18	0.48	6.87	0.36	4840
4841	Home Mixed Fertilizer 3–M–L–46	Simsbury: Cullman Bros., Inc.	5.25	0.35	5.15	4.80	0.45	6.27	0.34	4841
4842	Home Mixed Fertilizer 3–S–1–2–46	Simsbury: Cullman Bros., Inc.	5.32	0.43	5.35	4.92	0.44	7.00	0.33	4842
4843	Home Mixed Fertilizer 3–S–3–46	Simsbury: Cullman Bros., Inc.	5.53	0.48	5.60	5.12	0.43	4.91	0.32	4843
4844	Home Mixed Fertilizer 3–T–14–46	Simsbury: Cullman Bros., Inc.	5.32	0.35	5.30	4.95	0.44	6.23	0.33	4844
4845	Home Mixed Fertilizer 3–V–2–46	Simsbury: Cullman Bros., Inc.	5.89	0.34	4.88	4.54	0.31	5.74	0.23	4845
4846	Home Mixed Fertilizer 3–Z–L–46	Simsbury: Cullman Bros., Inc.	5.37	0.37	4.78	4.41	0.44	7.04	0.33	4846
4884	Home Mixed Fertilizer 1–A–1–46	Simsbury: Cullman Bros., Inc.	5.54	0.36	5.88	5.52	0.20	5.46	0.15	4884
4885	Home Mixed Fertilizer 1–A–2–46	Simsbury: Cullman Bros., Inc.	5.24	0.44	5.45	5.01	0.23	5.69	0.17	4885
4886	Home Mixed Fertilizer 1–A–3–46	Simsbury: Cullman Bros., Inc.	5.76	0.50	6.15	5.65	0.16	5.53	0.12	4886
4887	Home Mixed Fertilizer 1–A–4–46	Simsbury: Cullman Bros., Inc.	5.52	0.38	5.28	4.90	0.21	4.96	0.16	4887
4888	Home Mixed Fertilizer 1–B–1–46	Simsbury: Cullman Bros., Inc.	5.44	0.60	7.30	6.70	0.24	5.28	0.18	4888
4889	Home Mixed Fertilizer 1–M–1–46	Simsbury: Cullman Bros., Inc.	5.00	0.35	6.65	6.30	0.33	6.19	0.25	4889
4890	Home Mixed Fertilizer 1–M–2–46	Simsbury: Cullman Bros., Inc.	5.68	0.35	5.98	5.63	0.41	4.71	0.31	4890
4891	Home Mixed Fertilizer 1–Ma–2–46	Simsbury: Cullman Bros., Inc.	5.36	0.40	6.85	6.45	0.25	5.89	0.19	4891
4892	Home Mixed Fertilizer 1–Mc–P–46	Simsbury: Cullman Bros., Inc.	4.53	0.28	5.85	5.57	0.47	6.50	0.35	4892
4893	Home Mixed Fertilizer 1–Stj–1–46	Simsbury: Cullman Bros., Inc.	5.55	0.43	6.40	5.97	0.20	5.30	0.15	4893
4894	Home Mixed Fertilizer 1–S–M–CS&NS–46	Simsbury: Cullman Bros., Inc.	10.76	0.15	2.60	2.45	0.21	1.28	0.16	4894

TABLE 6. ANALYSES OF SPECIAL AND HOME MIXTURES—(*Concluded*)

Station No.	Name of mixture	Sampled or submitted by	Total nitrogen per cent	Per cent phosphoric acid			Per cent potash			Station No.
				Citrate-insoluble	Total	So-called "available"	As muriate	Total	Chlorine	
4932	Home Mixed Fertilizer 2–H–1–46	Simsbury: Cullman Bros., Inc.	4.75	0.20	6.65	6.45	0.32	6.22	0.24	4932
4933	Home Mixed Fertilizer 2–H–2–46	Simsbury: Cullman Bros., Inc.	5.00	0.20	6.55	6.35	0.32	5.71	0.24	4933
4934	Home Mixed Fertilizer 2–H–5–46	Simsbury: Cullman Bros., Inc.	4.76	0.30	7.25	6.95	0.31	6.34	0.23	4934
4935	Home Mixed Fertilizer 2–Ha–1–46	Simsbury: Cullman Bros., Inc.	5.00	0.25	6.98	6.73	0.45	6.09	0.34	4935
4936	Home Mixed Fertilizer 2–Ha–2–46	Simsbury: Cullman Bros., Inc.	4.94	0.23	6.08	5.85	0.31	5.48	0.23	4936
4937	Home Mixed Fertilizer 2–K–1–46	Simsbury: Cullman Bros., Inc.	4.96	0.15	6.23	6.08	0.24	4.79	0.18	4937
4938	Home Mixed Fertilizer 2–K–2–46	Simsbury: Cullman Bros., Inc.	4.98	0.20	6.40	6.20	0.36	5.21	0.27	4938
4939	Home Mixed Fertilizer 2–K–3–46	Simsbury: Cullman Bros., Inc.	4.94	0.15	6.68	6.53	0.51	6.16	0.38	4939
4940	Home Mixed Fertilizer 2–K–6–46	Simsbury: Cullman Bros., Inc.	4.84	0.20	6.75	6.55	0.32	5.73	0 24	4940
4941	Home Mixed Fertilizer 2–L&B–L–46	Simsbury: Cullman Bros., Inc.	5.29	0.20	5.78	5.58	0.36	5.32	0.27	4941
4942	Home Mixed Fertilizer 2–N2&SJ–46	Simsbury: Cullman Bros., Inc.	5.42	0.23	6.18	5.95	0.32	6.09	0.24	4942
4943	Home Mixed Fertilizer 2–N–3–46	Simsbury: Cullman Bros., Inc.	5.29	0.23	7.02	6.79	0.45	6.20	0.34	4943
5170	Fertilizer Mixture No. 1 A	West Hartford: General Cigar Co., Inc., Farming Division	5.44	0.15	4.08	3.93	0.27	5.68	0.20	5170
5426	Tobacco Fertilizer	West Hartford: General Cigar Co., Inc., Farming Division	5.98	0.20	3.15	2.95	0.88	6.30	0.66	5426
5532	Fertilizer Mixture No. 3	West Hartford: General Cigar Co., Inc., Farming Division	5.29	0.43	4.13	3.70	0.29	5.70	0.22	5532
5533	Buckland Mixture No. 3	West Hartford: General Cigar Co., Inc.	5.45	0.38	3.90	3.52	0.35	5.29	0.26	5533
5716	Home Mixture 46 A	Hartford: L. B. Haas & Co.	5.95	0.28	5.63	5.35	1.10	6.59	0.83	5716
5717	Home Mixture 46 B	Hartford: L. B. Haas & Co.	6.26	0.28	5.85	5.57	0.40	6.74	0.30	5717
5718	Home Mixture 46 C	Hartford: L. B. Haas & Co.	6.45	0.43	5.45	5.02	0.74	6.41	0.56	5718
5719	Home Mixture 46 D	Hartford: L. B. Haas & Co.	5.96	0.20	4.40	4.20	0.44	6.40	0.33	5719
5720	Home Mixture 46 E	Hartford: L. B. Haas & Co.	6.24	0.25	5.03	4.78	0.47	6.38	0.35	5720
5721	Home Mixture 46 F	Hartford: L. B. Haas & Co.	8.03	0.40	3.45	3.05	0.82	4.09	0.62	5721
5810	Fertilizer A	Buckland: Meyer & Mendelsohn, Inc.	6.00	0.28	5.48	5.20	0.72	6.72	0.54	5810
5811	Fertilizer B	Buckland: Meyer & Mendelsohn, Inc.	6.27	0.55	5.50	4.95	0.72	5.49	0.54	5811
5850	Tobacco Mixture Fertilizer	So. Windsor: L. W. Newberry	7.27	0.30	5.93	5.63	1.50	12.60	1.13	5850

Station No.	Name of mixture	Sampled or submitted by	Per cent nitrogen		Per cent phosphoric acid		Per cent potash		Station No.
			Found	Guaranteed	Found	Guaranteed	Found	Guaranteed	
5733	Pulverized Sheep and Goat Manure. The American Agricultural Chemical Co., No. Weymouth, Mass.	West Haven: American Agricultural Chemical Co.	1.65	1.25	1.83	1.00	3.76	2.00	5733
5587	Sheep Manure. Apothecaries Hall Co., Waterbury, Conn.	New London: Eaton & Wilson Hardware	1.88	1.00	1.83	0.50	3.66	1.00	5587
5700[8]	Sheep Manure. Apothecaries Hall Co., Waterbury, Conn.	Middletown: Long Lane Farm	1.81	1.00	1.90	0.50	4.15	1.00	5700
5836	Armour's Pulverized Sheep Manure. Armour Fertilizer Works, New York, N. Y.	East Windsor Hill: David Ahearn	1.59	1.50	1.37	1.00	1.61	2.50	5836
5550	Driconure. Atkins and Durbrow, Inc., New York, N. Y.	New Haven: Lightbourne & Pond	2.82	2.00	2.60	...[1]	1.47	1.00	5550
5574	Corenco Sheep Manure. Consolidated Rendering Co., Boston, Mass.	Wallingford: A. E. Hall	1.71	1.25	1.58	1.00	3.24	2.00	5574
5626	Davey Shredded Cattle Manure. The Davey Tree Expert Co., Kent, Ohio	Old Greenwich: The Davey Tree Expert Co.	2.12	1.00	2.00	...[2]	2.38	2.00	5626
5649	Norwood Brand Sheep Manure. Norwood Brand Fertilizer Co., No. Reading, Mass.	Bridgeport: Willis Seed Store	1.47	1.83	0.48	...[3]	2.73	1.03	5649
5557	Wizard Brand Cow Manure. The Pulverized Manure Co., Chicago 9, Ill.	Thompsonville: Brainard Nursery & Seed Co.	1.91	2.00	1.50	...[4]	1.60	1.00	5557
5566	Wizard Brand Pulverized Sheep Manure. The Pulverized Manure Co., Chicago 9, Ill.	Thompsonville: Brainard Nursery & Seed Co.	1.76	2.00	2.40	...[5]	3.29	2.00	5566
5706	Gro-Fast Sheep Manure. The Rogers & Hubbard Co., Portland, Conn.	Middletown: Meech & Stoddard, Inc.	1.60	1.25	1.85	1.00	3.57	2.50	5706
5749	Sawconure. Stumpp & Walter Co., New York 8, N. Y.	Stamford: Stumpp & Walter Co.	3.67	2.00	2.73	...[6]	1.61	1.00	5749
5583	Sheep Manure. Swift & Co., Plant Food Div., Baltimore, Md.	Groton: C. W. Campbell Co.	1.48	1.50	1.80	...[7]	3.84	2.50	5583
5756	Bovung. Walker-Gordon Laboratory Co., Plainsboro, N. J.	So. Norwalk: Fox Cycle Hardware Co.	2.07	2.00	1.80	1.00	2.54	1.00	5756

[1] Guaranteed "available" phosphoric acid, 1.00 per cent; found 2.37 per cent.
[2] Guaranteed "available" phosphoric acid, 1.00 per cent; found 1.77 per cent.
[3] Guaranteed "available" phosphoric acid, 0.89 per cent; found 0.35 per cent.
[4] Guaranteed "available" phosphoric acid, 1.00 per cent; found 1.10 per cent.
[5] Guaranteed "available" phosphoric acid, 1.00 per cent; found 2.20 per cent.
[6] Guaranteed "available" phosphoric acid, 1.00 per cent; found 2.60 per cent.
[7] Guaranteed "available" phosphoric acid, 1.00 per cent; found 1.50 per cent.
[8] State purchase.

TABLE 8. ANALYSES OF LIMESTONE AND SIMILAR MATERIALS

Station No.	Manufacturer and brand	Sampled from stock of, or sent by	Chemical analysis: Per cent lime, Found	Per cent lime, Guaranteed	Per cent magnesia, Found	Per cent magnesia, Guaranteed	Total oxides, per cent	Mechanical analysis (in percentage): 20 mesh	100 mesh	Station No.
	Submitted by Station Agent									
	Lee Lime Corp., Lee, Mass.									
5865	Tobey Agra Hydrate	West Suffield: H. L. Oppenheimer & Son	39.86	35.00	28.09	25.00	67.95	...	...	5865
	Submitted by Purchaser									
	Conklin Limestone Co., Canaan, Conn.									
5934	Limestone—Sample #1 North	Canaan: Conklin Limestone Co.	38.46	...	12.74	...	51.20	...	...	5934
5935	Limestone—Sample #2 South	Canaan: Conklin Limestone Co.	32.23	...	14.81	...	47.04	...	...	5935
	Connecticut Agstone Co., Danbury, Conn.									
5714	Ground limestone	Hartford: Production and Marketing Administration	41.72	...	4.89	...	46.61	100.0	60.5	5714
	Manufacturer Unknown									
4711	Lime	Hartford: Consolidated Cigar Corp.	47.09	...	33.00	...	80.09	...	...	4711
5824	Lime–10 ton G	Hartford: Consolidated Cigar Corp.	46.42	...	32.55	...	78.97	...	...	5824
4957	Pulverized limestone	Canaan: Robert D. May	30.39	...	21.14	...	51.53	...	...	4957
4958	Gray limestone	Canaan: Robert D. May	30.56	...	21.06	...	51.62	...	...	4958
4959	White limestone	Canaan: Robert D. May	29.93	...	20.12	...	50.05	...	...	4959
4882	Limestone #1	Canaan: James R. Place	29.79	...	20.47	...	50.26	...	...	4882
4883	Limestone #2	Canaan: James R. Place	30.06	...	21.46	...	51.52	...	...	4883
4656	Ground limestone	Hartford: Production and Marketing Administration	27.91	...	16.58	...	44.49	...	...	4656

Station No.	Manufacturer and brand	Place of sampling	Per cent nitrogen: In nitrates	In ammonia	Organic water-soluble	Organic active-insoluble	Organic inactive-insoluble	Total	Per cent phosphoric acid: Citrate-insoluble	Total	So-called "available"	Per cent potash: As muriate	Total	Station No.
	American Agricultural Chemical Co., No. Weymouth, Mass.													
5755	Agrico for Broadleaf Evergreens 6–10–4	Darien	0.00	5.38	0.20	0.53	0.13	6.24	1.55	12.58	10.03	4.01	4.01	5755
5610	Agrico for Gardens 4–12–4	Greenwich	0.78	2.92	0.40	0.28	0.18	4.56	1.10	14.00	12.90	4.39	4.39	5610
5605	Agrico for Gardens 5–10–5	Milford	0.42	4.24	0.36	0.21	0.11	5.34	0.78	11.25	10.47	5.29	5.29	5605
	Goulard & Olena, Inc., New York, N. Y.													
5757	G & O Special 7–8–5 Rose Food	South Norwalk	1.41	3.12	0.84	1.22	0.32	6.91	0.48	9.33	8.85	4.94	4.94	5757
	A. H. Hoffman, Inc., Landisville, Pa.													
5767	Hoffman Bone Meal	South Norwalk	...	...	...	...	...	3.86	...	20.60	...	...	...	5767
5768	Hoffman's Cow Manure 2–1–1	South Norwalk	0.00	0.28	0.86	...	...	2.74	0.13	2.20	2.07	...	1.65	5768
5769	Hoffman Sheep Manure	South Norwalk	0.00	0.08	0.12	...	...	1.95	...	1.78	...	...	2.58	5769
	Miller Chemical & Fertilizer Corp., Baltimore, Md.													
5894	VHPF 5–25–15	Warehouse Point	5.90	0.56	0.00	...	...	6.64	trace	23.00	23.00	0.20	20.22	5894
	The Pulverized Manure Co., Chicago, Ill.													
5612	Wizard Brand Pulverized Sheep Manure 2–1–2	Greenwich	0.00	0.24	0.37	0.85	1.12	2.28	0.28	2.10	1.82	...	3.95	5612
	The Rogers & Hubbard Co., Portland, Conn.													
5639	Gro-Fast Plant Food 5–8–5	Hartford	0.74	2.50	0.94	0.84	0.39	5.41	0.53	10.35	9.82	6.05	6.05	5639
	Stumpp & Walter Co., New York, N. Y.													
5751	Sawco Nitrate of Soda 15–0–0	Stamford	16.06	...	...	...	...	...	...	...	...	...	...	5751
5630	Sawco Superphosphate 0–20–0	Stamford	...	...	...	...	...	...	0.38	20.90	20.52	...	...	5630
5752	Treewiz 8–6–4	Stamford	2.38	5.60	0.16	...	...	8.34	0.50	6.93	6.43	4.65	4.65	5752
	Swift & Company, Baltimore, Md.													
5614	Vigoro Complete Plant Food 4–12–4	Greenwich	0.49	3.56	0.00	...	...	4.27	0.50	13.35	12.85	4.22	4.22	5614
5623	Vigoro Complete Plant Food (for house plants) 4–12–4	Greenwich	0.45	3.56	0.16	...	...	4.43	0.45	13.58	13.13	4.30	4.30	5623
5622	Vigoro Complete Plant Food (Tablets) 4–12–4	Greenwich	0.30	3.38	0.14	...	...	4.11	0.85	13.55	12.70	4.32	4.32	5622

TABLE 10. ANALYSES OF OTHER MISCELLANEOUS MATERIALS

Station No.	Material	Moisture per cent	Ash per cent	Organic and volatile per cent	Nitrogen per cent	Phosphoric acid per cent		Potash per cent	Other analytical items per cent
						Total	So-called "available"		
5105	Apple tree fertilizer	. . .	. . .	. . .	11.47	3.53	3.11	3.49	Nitrate N 8.29; ammonia N 3.00; sol. organic N 0.18; Cl 2.55.
5054	Cottonseed flour	. . .	. . .	. . .	8.69	3.58	3.43	1.78	Cl trace.
4837	Manure	83.0	. . .	. . .	0.33	0.13	. . .	0.39	
3544	Peat	77.58	6.23	16.19	0.39	. . .	. . .	. . .	
4989	Peat moss and poultry manure A	. . .	. . .	. . .	2.65	3.25	. . .	2.15	
4990	Peat moss and poultry manure B	. . .	. . .	. . .	2.63	2.97	. . .	2.44	
5520	Peat moss and poultry manure	7.64	18.55	73.81	3.65	3.33	. . .	2.00	
5673	Peat moss and poultry manure	9.22	3.30	87.48	0.86	0.25	0.20	0.35	
5983	Plastic	. . .	. . .	. . .	20.28	. . .	. . .	. . .	Sol. organic N 0.80; insol. organic N 19.48; active insol. alk. permanganate method 40.0.
6515	Plastic	. . .	. . .	. . .	18.62	. . .	. . .	. . .	Ammonia N 0.04; sol. organic N 3.46; insol. organic N 15.12; active insol. alk. permanganate method 50.0.
5654	Sewage sludge	64.92	22.72	12.36	0.70	0.48	. . .	0.10	Insol. organic N 0.67; active insol. alk. permanganate method 54.0.
5851	Sewage sludge	5.08	41.98	52.94	2.90	1.33	0.88	0.41	Sol. organic N 0.20; insol. organic N 2.70; active insol. alk. permanganate method 56.2.
7039	Sewage sludge	4.40	60.14	35.46	1.61	2.20	1.15	0.06	Cl 0.23; total S 1.13; fat 5.28.
6514	Stable liquid	. . .	. . .	. . .	0.22	0.021	. . .	0.60	Nitrate N 0.00; ammonia N 0.14; sol. organic N 0.08.
4944	Tobacco stems	. . .	. . .	. . .	2.54	1.18	. . .	9.68	
3852	Zinc sulfate	. . .	. . .	. . .	. . .	. . .	. . .	. . .	$ZnSO_4$, H_2O 99.0; ZnO 0.5; MgO 0.10; Fe 0.02; Ca, Mn, Al, Cd, Cl traces.

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Circular 163 **January, 1946**

Connecticut Agricultural Experiment Station
New Haven

Laws and Regulations Concerning The Inspection of Nurseries in Connecticut And Transportation of Nursery Stock[1]

Compiled by
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THE PRESENT LAW governing the inspection and transportation of nursery stock was enacted in 1925, and published as Chapter 265, Public Acts of 1925. In the revision of the General Statutes of 1930, and as amended effective March 16, 1943, this law appears in slightly different form in Sections 2135 to 2140, inclusive, as follows:

Sec. 2135. Certificate of inspection of imported nursery stock. All nursery stock shipped into this state shall bear on each package a certificate that the contents of such package have been inspected by a state or government officer and that such contents appear free from all dangerous insects and diseases. If nursery stock shall have been brought into the state without such a certificate, the express, freight or other transportation company or person shall, before delivering shipment to consignee, notify the state entomologist of the facts, giving name and address of consignee, origin of shipment and approximate number of cars, boxes or packages and probable date of delivery to the consignee. The state entomologist may cause the inspection and, if infested, the treatment of the stock. No person, firm or corporation shall unpack any woody field-grown nursery or florists' stock brought into this state from foreign countries except in the presence of an inspector unless given permission to do so by the state entomologist or one of his assistants. If such stock shall be found infested with any dangerous pests, the state entomologist may order it treated. Any person violating any of the provisions of this section shall be fined not more than fifty dollars. No provision of section 6132 shall be construed to apply to any bale, box, package or load or to the contents thereof, which shall be transported into this state from outside the state, provided the same shall be labeled in such a manner as to indicate the place from which it shall have been transported and shall be accompanied by the certificate prescribed by this section.

Sec. 2136. Nursery stock; powers of State Entomologist. The state entomologist or his assistants shall, upon application, inspect at least once each year all nurseries at which woody field-grown hardy trees and plants shall be grown for sale or shipment; may inspect any nursery stock when dug, before shipment or at destination; may inspect nurseries at any time for the purpose

[1] Revision of Circular 158, March, 1944.
Section 6132, referred to above, has been revised. See Section 1695c, 1935 Supplement.

of controlling plant pests or to ascertain whether such pests exist in nurseries; may prescribe forms for registration, certificates and permits and may make rules and regulations regarding time and methods of inspection; may destroy or treat or order the destruction or treatment of, and prohibit the movement of, plants infested with dangerous pests; may coöperate with agents of the United States Department of Agriculture in the inspection of nurseries and control of plant pests; may, at reasonable times, enter any public or private grounds in performance of his duties under the provisions of this section and sections 2137 and 2138. In case orders shall be issued for the destruction or treatment of infested plants, the owner, manager or agent of the nursery shall, within a reasonable time from the date of such order, destroy such plants as shall be ordered destroyed and make such treatment within the time specified in the order or be subject to the penalty provided in section 2140.

Sec. 2137. Nurserymen and dealers to register. All nurserymen shall register with the state entomologist each year, on or before July first, and make application for inspection, and furnish such data on such blanks as the state entomologist shall prescribe and furnish. In case a nurseryman shall fail to make such application on or before July first, he shall pay to the state entomologist the cost of such inspection. All firms, stores and individuals who shall sell but shall not grow nursery stock shall be classed as dealers, and shall, each year, on or before March first, register with the state entomologist, giving the chief sources of their nursery stock and such data as he may require, on such forms as he may prescribe and furnish, and the state entomologist may issue a permit allowing such dealer to sell such nursery stock. The state entomologist may make such regulations as he deems necessary to govern the shipment of nursery stock into the state by any nursery, person, firm or corporation outside the state. The state entomologist shall keep a record of all money received as costs for inspection, and such money shall be deposited with the state treasurer.

Sec. 2138. Nursery certificate. Uninspected stock. The state entomologist shall issue to regular nurseries certificates, valid until the first day of August following the date of issue and covering the stock inspected and such other stock as shall have been received under valid certificates of inspection and may issue temporary permits covering certain portions thereof, and permits to dealers. All such certificates and permits may be revoked for cause. Nursery stock which shall not have been inspected or stock from a nursery not holding a valid certificate of inspection shall not be sold or transported, and transportation companies shall refuse to accept any shipment not bearing such certificate or some form of permit issued by the state entomologist, and all nurserymen shall furnish a certificate, and all dealers a permit, to accompany each package of stock sold or transported, but no provision of section 2136, 2137 or 2138 shall prevent or render liable any person or firm transporting stock from one field or property to another field or property belonging to or operated by such person or firm when such stock is not to be immediately sold or offered for sale and when such transportation shall not violate any established federal or state embargo or quarantine regulations.

Sec. 2139. Nursery and nursery stock defined. For the purposes of sections 2136, 2137 and 2138, any place at which hardy trees, shrubs and vines shall be propagated or grown out of doors for commercial purposes shall be considered a nursery, and such stock shall be regarded as nursery stock. Hardy herbaceous perennial plants, including strawberry plants, may be subject to the same provisions regarding inspection and pest control, if, in the opinion of the state entomologist, it shall be desirable to control the movement of such plants. Florists' ordinary plants, unless woody and field-grown, shall not be included.

Sec. 2140. Penalty. Appeal. Any person who shall interfere with the state entomologist or his assistant in the performance of his duties under the provisions of sections 2136, 2137 and 2138, or any person, firm or corporation who shall violate any of the provisions thereof, shall be fined not more than fifty dollars. Any person aggrieved by any order issued under the provisions of sections 2136, 2137 and 2138 may appeal to the superior court, or to any judge thereof if said court shall not be in session, and said court or such judge may grant such relief or issue such order or judgment in the premises as to equity may appertain.

REGISTRATION

All persons in Connecticut who grow nursery stock for sale or shipment are required to register with the State Entomologist each year before July 1. The annual inspection of nurseries begins in July and nurseries in existence the preceding year must bear the cost of inspection if they fail to register before July 1.

All persons who buy and sell but do not grow nursery stock are also required to register with the State Entomologist and receive a dealer's permit. No inspection is required, but a dealer is allowed to handle only stock procured from regular nurseries holding certificates.

CERTIFICATION OF NURSERIES

Inspection and Pest Control

In July, after the nurseries have registered, the inspection force examines the nurseries by groups to avoid unnecessary travel, beginning with those that request early attention. In case pests are found, directions for eradicating or controlling them are given by the inspector or sent from the office, and the owner or manager is expected to carry them out promptly and to notify this office when completed. Pests must be eradicated before a certificate can be issued.

Nursery Certificates

The original certificate issued by the State Entomologist under Section 2138 is to be kept in the nurseryman's possession, and is not to be attached to any package of nursery stock. It applies to the whole nursery which has been inspected and to such purchased stock as has been received from other nurseries under the certificate of a state or government officer. If any stock is received from outside the State unaccompanied by such a certificate, the State Entomologist should be notified at once so that it may be inspected.

An exact transcript of the certificate including number and date may be printed on labels or tags for shipping and must be attached to each package sent out of the nursery. An additional statement, made by the owner, that the stock has been fumigated will be required in some states. *The law now requires that the inspection certificate be attached to every package shipped to points both within the State of Connecticut and outside. Please see that a copy always accompanies each sale whether shipped by freight, express, mail, automobile or whether carried away by the purchaser.*

After the date of expiration, which is a part of each certificate, the document becomes invalid and should not be attached to any box, bale or package. The nurseryman has no right to change the date or any other portion of the certificate.

The improper use or abuse of a certificate will not be tolerated, and the certificate may be revoked for cause.

Duplicate copies of certificates for filing in other states will be furnished on request of the nurseryman.

Dealers' Permits

The original permit issued by the State Entomologist under Section 2137 should be kept in the dealer's possession and is not to be attached to any package or shipment of nursery stock, though copies may be made for this purpose. These may be typewritten or printed and a copy must go with each separate sale from stores, and with each shipment or package of nursery stock transported. This copy must be an exact transcript, and must include number, date of issue and of expiration. After the expiration date, the permit becomes invalid and should not be used. The dealer has no right to alter the date or any other portion of the permit. This permit may be revoked for improper use or abuse, and for not complying with the law.

Shippers' Permits

The out-of-state shippers' permits have been discontinued, as well as the necessity of filing out-of-state nursery certificates with the State Entomologist's office. All that is required now for shipments of nursery stock consigned to Connecticut is to attach a copy of valid certificate to the box, bale or parcel of nursery stock.

Package Certificates

Occasionally, individuals and firms not in the nursery business wish to ship a few trees or shrubs but cannot do so without inspection certificates. If such materials can be inspected by our men on their usual trips without extra travel and expense, this will be done on request, as an accommodation. Other inspections may be arranged by special appointment, or plants can be sent to the Station with address and postage for forwarding, and here they will be examined and sent along.

The U. S. Postal Laws and Regulations, Section 595(a), governs the mailing of plants and plant products, and reads as follows:

"Nursery stock, including all field-grown florists' stock, trees, shrubs, vines, cuttings, grafts, scions, buds, fruit pits and other seeds of fruit and ornamental trees or shrubs, and other plants and plant products for propagation, except field, vegetable and flower seeds, bedding plants and other herbaceous plants, bulbs and roots, may be admitted to the mails only when accompanied with a certificate from a State or Government inspector to the effect that the nursery or premises from which such stock is shipped has been inspected within a year and found free from injurious insects and plant diseases, and the parcel containing such stock is plainly marked to show the nature of the contents and the name and address of the sender."

Such materials may be mailed without certificates to any Agricultural Experiment Station or to the United States Department of Agriculture. Florists' plants (not woody, field-grown) and vegetable or other annual herbaceous plants do not require certificates but must be plainly marked as to contents, origin and destination. Package certificates apply only to the contents of the packages on which they are placed, and the contents of which have been examined.

INTERSTATE REGULATIONS

At the present time every state in the Union has laws or regulations in regard to the inspection, certification and transportation of nursery stock. These all have one object in view, namely, the control of plant pests. But conditions are not uniform throughout the United States, and each state has established such requirements as seem to give it the best protection, with the result that there are many different regulations.

This situation assumes a serious aspect to the nurseryman who may wish to fill orders received from 18 or 20 or more different states. In order to tabulate and bring together these varying regulations in convenient form for the use of Connecticut nurserymen, this bulletin has been prepared. It should be understood that it presents only a brief digest in each case, and if any points are not clear, the nurseryman should write to the officer in charge of inspection in that state for more information.

In addition to the various state laws and regulations, there are several Federal quarantines regulating the shipment of nursery stock. A digest of these has been included in this bulletin, together with the regulations of the District of Columbia and of the Dominion of Canada.

Quarantines

The shipment out of Connecticut of nursery stock and forest products is now regulated by five different Federal quarantines, as follows.

Gypsy moth	Federal	quarantine	No.	45
Dutch elm disease	"	"	"	71
Japanese beetle	"	"	"	48
White pine blister rust	"	"	"	63
Barberry-grain black stem rust	"	"	"	38

In the quarantines relating to the gypsy moth and brown-tail moth and the Japanese beetle, provision is made for the movement of the restricted articles interstate from the regulated areas to points outside under a certificate of inspection relating to these respective pests.

In addition to the quarantines mentioned above, many state quarantines on account of the European corn borer prevent the shipment of certain kinds of plants from the infested states to points outside, unless certified. The Federal corn borer quarantine has been revoked but state inspectors are authorized to make inspections and issue certificates.

Gypsy Moth and Brown-Tail Moth. Quarantine No. 45, as revised effective October 10, 1945, regulates the interstate movement of all woody nursery stock including trees, shrubs, vines, and parts thereof, timber products, Christmas trees and Christmas greens, and greenery such as boxwood, holly and laurel, cones, and stone and quarry products from the generally infested area to points outside, including the suppressive area. Nursery stock and other regulated articles must be inspected and certified as free from gypsy and brown-tail moths. The interstate movement of living gypsy or brown-tail moths is prohibited. For names and addresses of inspectors and towns in which they operate, see page 8. The areas under regulation are as follows:

Generally Infested Area

Connecticut. Counties of Hartford, Middlesex, New London, Tolland and Windham; towns of Barkhamsted, Canaan, Colebrook, Cornwall, Goshen, Harwinton, Kent, Litchfield, Morris, New Hartford, Norfolk, North Canaan, Plymouth, Salisbury, Sharon, Thomaston, Torrington, Warren and Winchester, in *Litchfield County*; towns of Branford, Guilford, Madison, Meriden, North Branford, North Haven, Waterbury and Wolcott, in *New Haven County*.

Maine. Counties of Androscoggin, Cumberland, Kennebec, Knox, Lincoln, Sagahoc, Waldo and York; towns of Avon, Berlin, Carthage, Chesterville, Crockertown, Dallas Plantation, Farmington, Freeman, Greenvale, Industry, Jay, Jerusalem, Kingfield, Madrid, Mount Abraham, New Sharon, New Vineyard, Perkins, Phillips, Rangeley Plantation, Redington, Salem, Sandy River Plantation, Strong, Temple, Washington, Weld, and Wilton, and Townships D and E, in *Franklin County*; all of *Hancock County* except Plantations 3, 4, 35 and 41; all that part of *Oxford County* south and southeast of and including the towns of Magalloway and Richardsontown; towns of Alton, Argyle, Bradford, Bradley, Carmel, Charleston, Clifton, Corinna, Corinth, Dexter, Dixmont, Eddington, Etna, Exeter, Garland, Glenburn, Grand Falls Plantation, Greenbush, Greenfield, Hampden, Hermon, Holden, Hudson, Kenduskeag, Levant, Milford, Newburgh, Newport, Orono, Orrington, Plymouth, Stetson, Summit and Veazie, and cities of Bangor, Brewer and Old Town, in *Penobscot County*; towns of Abbott, Atkinson, Dover, Foxcroft, Guilford, Kingsbury Plantation, Parkman, Sangerville and Wellington, in *Piscataquis County*; all that part of *Somerset County* south and southeast of and including Highland and Pleasant Ridge Plantations, town of Moscow, and Mayfield Plantation; towns of Beddington, Cherryfield, Columbia, Deblois, Harrington, Millbridge and Steuben, and Plantations 18 and 24, in *Washington County*.

Massachusetts. The entire State.

New Hampshire. Counties of Belknap, Carroll, Cheshire, Grafton, Hillsboro, Merrimack, Rockingham, Strafford and Sullivan; all that part of *Coos County* lying south of and including the towns of Stratford, Odell, Dummer and Cambridge.

New York. Counties of Rensselaer, Saratoga, Schenectady and Washington; all of *Albany County* except the town of Rensselaerville; all of *Columbia County* except the towns of Clermont, Germantown, Greenport and Livingston, and the city of Hudson; towns of Amenia, Northeast and Pine Plains in *Dutchess County*; towns of Chesterfield, Crown Point, Essex, Moriah, Ticonderoga, Westport and Willsboro, in *Essex County*; towns of Broadalbin, Johnstown, Mayfield, Northampton and Perth, and the cities of Gloversville and Johnstown, in *Fulton County*; towns of Coxsackie and New Baltimore, in *Greene County*; towns of Amsterdam, Florida, Glen and Mohawk, and the city of Amsterdam, in *Montgomery County*; and the towns of Bolton, Caldwell, Hague, Luzerne, Queensbury, Stoney Creek, Thurman and Warrensburg, and the City of Glens Falls, in *Warren County*.

Rhode Island. The entire State.

Vermont. Counties of Addison, Bennington, Orange, Rutland, Windham and Windsor; towns of Barnet, Danville, Groton, Kirby, Peacham, Ryegate, St. Johnsbury and Waterford, in *Caledonia County*; towns of Buels Gore, Charlotte, Colchester, Essex, Hinesburg, Huntington, Jericho, Richmond, St. George, Shelburne, South Burlington and Williston, and the cities of Burlington and Winooski, in *Chittenden County*; towns of Concord, Granby, Guildhall, Lunenburg, Maidstone and Victory, in *Essex County*; town of Elmore, in *Lamoille County*; towns of Barre, Berlin, Cabot, Calais, East Montpelier, Fayston, Marshfield, Middlesex, Montpelier, Moretown, Northfield, Plainfield, Roxbury, Waitsfield, Warren, Woodbury and Worcester in *Washington County*.

The Suppressive Area

Connecticut. Towns of Canaan, Cornwall, Goshen, Kent, Litchfield, Morris, Norfolk, North Canaan, Salisbury, Sharon and Warren, in *Litchfield County*.

Massachusetts. County of Berkshire; and the town of Monroe, in *Franklin County*.

New York. Counties of Rensselaer, Saratoga, Schenectady and Washington; all of *Albany County* except the town of Rensselaerville; all of *Columbia County* except the towns of Clermont, Germantown, Greenport and Livingston, and the city of Hudson; towns of Amenia, Northeast and Pine Plains, in *Dutchess County*; towns of Chesterfield, Crown Point, Essex, Moriah, Ticonderoga, Westport and Willsboro, in *Essex County*; towns of Broadalbin, Johnstown, Mayfield, Northampton and Perth, and the cities of Gloversville and Johnstown, in *Fulton County*; towns of Coxsackie and New Baltimore, in *Greene County*; towns of Amsterdam, Florida, Glen and Mohawk, and the city of Amsterdam, in *Montgomery County*; and the towns of Bolton, Caldwell, Hague, Luzerne, Queensbury, Stoney Creek, Thurman and Warrensburg, and the city of Glens Falls, in *Warren County*.

Vermont. County of Addison; towns of Arlington, Bennington, Dorset, Glastenbury, Manchester, Pownal, Rupert, Sandgate, Shaftsbury, Stamford, Sunderland and Woodford, in *Bennington County*; towns of Buels Gore, Charlotte, Colchester, Essex, Hinesburg, Huntington, Jericho, Richmond, St. George, Shelburne, South Burlington and Williston, and the cities of Burlington and Winooski, in *Chittenden County*; towns of Benson, Brandon, Castleton, Chittenden, Clarendon, Danby, Fair Haven, Hubbardton, Ira, Mendon, Middletown Springs, Pawlet, Pittsford, Poultney, Proctor, Rutland, Sudbury, Tinmouth, Wells, West Haven and West Rutland, and the city of Rutland, in *Rutland County*; and the towns of Fayston and Warren in *Washington County*.

Japanese Beetle. Quarantine No. 48, with regulations revised and amended effective February 17, 1945, regulates the interstate movement of all nursery stock and other materials, including soil, from the regulated areas to or through outside points. The regulated areas include the entire states of Connecticut, Delaware, Massachusetts, New Jersey and Rhode Island, the District of Columbia, and parts of the states of Maine, Maryland, New Hampshire, New York, Ohio, Pennsylvania, Vermont, Virginia and West Virginia.

Inspection and Certification

The district inspectors are responsible for the inspection and certification of quarantined materials on account of the gypsy moth and Japanese beetle quarantines. In general, application for inspection should be sent in advance to inspectors. The following is a list of these men and the towns in which they make inspections:

W. W. Eells, Box 63, Sta. A, Manchester. Telephone Manchester 4482.

Avon
Barkhamsted
Bloomfield
Bolton
Burlington
Canaan
Canton
Colebrook
Cornwall
Coventry
East Granby
East Hartford
East Windsor
Ellington
Enfield
Farmington
Goshen
Granby
Hartford
Hartland
Harwinton
Kent
Litchfield
Manchester
Mansfield
Morris
New Hartford
Norfolk
North Canaan
Salisbury
Sharon
Simsbury
Somers
South Windsor
Stafford
Suffield
Tolland
Torrington
Union
Vernon
Warren
West Hartford
Willington
Winchester
Windsor
Windsor Locks

J. F. McDevitt, Box 45, Middletown. Telephone Middletown 1613.

Andover
Berlin
Branford
Bristol
Chester
Clinton
Colchester
Columbia
Cromwell
Durham
East Haddam
East Hampton

Essex
Glastonbury
Guilford
Haddam
Hebron
Killingworth
Lebanon
Madison
Marlborough
Meriden
Middlefield
Middletown
New Britain
Newington
North Branford
North Haven
Old Saybrook
Plainville
Plymouth
Portland
Rocky Hill
Saybrook
Southington
Thomaston
Waterbury
Westbrook
Wethersfield
Wolcott

William J. Ahearn, Box 63, Westerly, R. I. Telephone Westerly 2422.

Ashford
Bozrah
Brooklyn
Canterbury
Chaplin
Eastford
East Lyme
Franklin
Griswold
Groton
Hampton
Killingly
Ledyard
Lisbon
Lyme
Montville
New London
North Stonington
Norwich
Old Lyme
Plainfield
Pomfret
Preston
Putnam
Salem
Scotland
Sprague
Sterling
Stonington
Thompson
Voluntown
Waterford
Windham
Woodstock

L. A. Devaux, Box 1106, New Haven. Telephone New Haven 5-6191.

All towns not listed above.

Black Stem Rust of Grains. Quarantine No. 38, as revised effective December 26, 1944, prohibits the movement of the common barberry or other species of plants (or parts of plants capable of propagation) of the genus *Berberis* (barberry) or of the genera *Mahonia* or *Mahoberberis* (Mahonias, holly grapes, holly barberries, or Oregon grapes) into any of the protected states, unless a permit shall have been issued therefor by the United States Department of Agriculture, except that no restrictions are placed on the shipment of Japanese barberry (*Berberis thunbergi*) or any of its horticultural varieties, or of cuttings of *Mahonia* shipped for decorative purposes and not for propagation. The protected states are: Colorado, Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Montana, Nebraska, North Dakota, Ohio, Pennsylvania, South Dakota, Virginia, Washington, West Virginia, Wisconsin and Wyoming.

Permits are issued to nurseries which grow only those species of *Berberis* and *Mahonia* which are immune or resistant to black stem rust infection. To apply for inspection, address the Bureau of Entomology and Plant Quarantine, Washington 25, D. C., before June 1 of each year.

Dutch Elm Disease. Quarantine No. 71, as revised effective October 1, 1941, and modified by Administrative Instructions (Circular B. E. P. Q. 517 effective November 10, 1941), prohibits the interstate movement from the regulated areas in New Jersey, New York, Connecticut and Pennsylvania, to or through any point outside

thereof, of any and all parts of elms of all species irrespective of whether nursery, forest or privately grown; logs or cordwood of such plants; and lumber or containers manufactured from such plants, except that elm lumber or elm products entirely free from bark are exempt from restrictions. Restricted plants or restricted products which originate outside the regulated areas may be moved through or reshipped from the regulated areas under provisions specified under the regulations.

Connecticut. *Fairfield County*; towns of Bethlehem, Bridgewater, Harwinton, Litchfield, Morris, New Milford, Roxbury, Thomaston, Torrington, Washington, Watertown and Woodbury, in *Litchfield County*; all of *New Haven County* except the towns of Cheshire, Madison, Prospect and Wolcott; and the town of Preston in *New London County*.

New Jersey. Counties of *Bergen*, *Essex*, *Hudson*, *Hunterdon*, *Mercer*, *Morris*, *Passaic*, *Somerset*, *Sussex*, *Union* and *Warren*; townships of Bordentown, Chesterfield, Mansfield, New Hanover, North Hanover, Pemberton and Springfield, the city of Bordentown, and the boroughs of Fieldsboro and Pemberton in *Burlington County*; all of *Middlesex County*, except the townships of Cranbury and Monroe and the boroughs of Helmetta, Jamesburg and Spotswood; all of *Monmouth County*, except the townships of Freehold, Millstone, Neptune and Wall and the boroughs of Avon-by-the-Sea, Belmar, Bradley Beach, Brielle, Freehold, Jersey Homestead, Manasquan, Neptune City, Sea Girt, South Belmar, Spring Lake and Spring Lake Heights; and the township of Plumstead in *Ocean County*.

New York. Counties of *Bronx*, *Dutchess*, *Kings*, *Nassau*, *New York*, *Orange*, *Putnam*, *Queens*, *Richmond*, *Rockland* and *Westchester*; town of Bethlehem in *Albany County*; towns of Chenango, Colesville, Conklin, Fenton, Kirkwood, Sanford, and Windsor in *Broome County*; towns of Afton, Bainbridge, Coventry and Greene in *Chenango County*; towns of Ancram, Claverack, Clermont, Copake, Gallatin, Germantown, Ghent, Livingston and Taghkanic in *Columbia County*; town of Deposit in *Delaware County*; town of Catskill in *Greene County*; town of Unadilla in *Otsego County*; town of Mamakating in *Sullivan County*; and all of *Ulster County* except the towns of Benning, Hardenbergh, Kingston, Olive, Shandaken and Woodstock.

Pennsylvania. Township of Amity in *Berks County*; all of *Bucks County* except the townships of Lower Southampton and Upper Southampton; townships of Lower Milford, Salisbury and Upper Saucon and the borough of Coopersburg in *Lehigh County*; townships of Hanover, Pittston and Plains, city of Wilkes-Barre, and the boroughs of Ashley, Edwardsville, Forty Fort, Kingston, Larksville, Plymouth, Sugar Notch, Warrior Run and Wyoming, in *Luzerne County*; townships of Middle Smithfield, Smithfield and Stroud, and the boroughs of Delaware Water Gap, East Stroudsburg and Stroudsburg in *Monroe County*; townships of Franconia, Hatfield, Lower Merion, Lower Moreland, Marlboro, New Hanover, Perkiomen, Salford, Upper Hanover, Upper Merion, West Norriton, and that portion of Whitemarsh Township northeast of Stanton Avenue, and the boroughs of Bridgeport, Bryn Athyn, East Greenville, Greenlane, Hatfield, Narberth, Pennsburg, Red Hill, Souderton, West Conshohocken and West Telford in *Montgomery County*; townships of Bethlehem, Hanover, Lower Mount Bethel, Lower Saucon, Upper Mount Bethel and Williams, the city of Easton, and the boroughs of Freemansburg, Glendon, Hellertown, Portland, West Easton and Wilson in *Northampton County*; ward 35 in the city of Philadelphia in *Philadelphia County*; and the townships of Harmony and Jackson and the borough of Lanesboro in *Susquehanna County*.

White Pine Blister Rust. Federal Quarantine No. 63 regulates the interstate movement throughout the United States of five-leaved pines and currant and gooseberry plants.

Ribes may be shipped into Connecticut only after obtaining Control Area permits (Federal Form E Q 415).

In order that five-leaved pines may be grown in blister rust-free areas, Connecticut has legally established control areas around eight nurseries located in the following towns: Barkhamsted, Cheshire, Cromwell, Killingly, New Milford, Simsbury, Tolland and Windsor. No currants or gooseberries may be grown in or shipped to within 1,500 feet of the nursery sanitation zones.

In addition to the towns listed above, control areas have been established in the following towns because of the importance of white pine: Cornwall, Killingly, Norfolk, North Canaan, Salisbury, Thompson, Voluntown and Woodstock. Any currants or gooseberries found growing within 900 feet of white pine stands in the above towns may be destroyed, whether or not infected with white pine blister rust.

Pine Shipments

Under the Federal regulations revised effective July 1, 1938, the movement of five-leaved pines is prohibited into the following states, except that no restrictions are placed on the interstate movement of such pines from or between these 11 entire states nor from the part of California described:

Arizona
California
That part lying south of the south line of the counties of Humboldt, Trinity, Tehama, Butte, Plumas and Lassen.
Colorado
Georgia
Kentucky
Nevada
New Mexico
North Carolina
South Carolina
Tennessee
Utah
Wyoming

No other restrictions or requirements are placed by these regulations on the interstate movement of five-leaved pines unless they are visibly infected with blister rust.

Currant and Gooseberry Shipments

The interstate movement of European black currant plants, *Ribes nigrum*, or plants of the wild native western species known as *R. bracteosum* and *R. petiolare*, is prohibited except to and between the states of Alabama, Arkansas, Florida, Kansas, Louisiana, Mississippi, Missouri, Nebraska, North Dakota, Oklahoma, South Dakota and Texas.

Currant and gooseberry plants shipped to the 11 entire states and part of California described in the preceding section relating to pine shipments, must be either dormant and defoliated or else dipped in lime-sulfur solution of 4.5° B. immediately before shipment. The solution is prepared by diluting one part of commercial concentrated lime-sulfur solution of 32° B. with eight parts of water.

A control area permit obtained from the state of destination must be attached to shipments of currant and gooseberry plants consigned to the following states:

California	Minnesota	Rhode Island
Connecticut	Montana	Tennessee
Georgia	New Hampshire	Vermont
Idaho	New Jersey	Virginia
Maine	New York	Washington
Maryland	North Carolina	West Virginia
Massachusetts	Ohio	Wisconsin
Michigan	Pennsylvania	

For further information regarding Federal quarantines and regulations, address: Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture, Washington 25, D. C.

REGULATIONS

District of Columbia

Each package of nursery stock (woody plants and parts capable of propagation, except domestic-grown seeds and fruit pits) entering the District of Columbia, must bear a valid certificate of inspection, and must be marked with the nature of the contents and with the name and address of both the consignor and consignee. Herbaceous perennial plants, including strawberry, bulbs and roots are required to be marked with the name and address of the consignor and the consignee and with the nature of the contents, but certification in advance is not required.

Bureau of Entomology and Plant Quarantine, Washington 25, D. C.

Dominion of Canada

Nursery stock and all plants for ornamental purposes, propagation or cropping (seeds and seed potatoes excepted), from the United States, can enter Canada only after permits (and official labels, if to

be sent by mail) have been procured by the importer from The Secretary, Destructive Insect and Pest Act Advisory Board, Ottawa, Canada. Applications must specify the quantity, kind, value, origin and destination of stock, the name and address of consignor and consignee, and whether the stock is to be shipped by mail or otherwise. The importer must retain the permit to present with the other papers in clearing the importation on arrival but he must furnish the permit number to the shipper, and this number must be marked on every container and on the shipping papers. A certificate of inspection issued at the time of packing must be supplied. The original certificate must accompany the way-bill with copy on containers. It must be signed by an authorized official of the state or county where the stock originated, contain the name and address of both consignor and consignee, and a declaration of kind and quantity of the stock. The following are designated as ports of importation:

Halifax, N. S.	Toronto, Ont. (Parcel post only)
Saint John, N. B.	Windsor, Ont.
Montreal, P. Q.	Winnipeg, Man.
Ottawa, Ont.	Estevan, Sask.
Niagara Falls, Ont.	Vancouver, B. C.

Prohibitions: Regulations prohibit the importation of conifers from New England; all five-leaf pines; black currant nursery stock, and parts thereof including seeds (except fresh fruits); barberry, genus *Berberis* (except hybrids, species and varieties determined immune from black stem rust of wheat); European buckthorn, *Rhamnus cathartica* L.; fresh peaches, peach nursery stock and peach fruit pits or seeds for propagation, into the Province of British Columbia from the states of Wisconsin, Illinois, Missouri, Arkansas and Texas and from all other states to the east of those mentioned; *Corylus* (hazel cob or filbert) into the Province of British Columbia from the states of Montana, Wyoming, Colorado, New Mexico and all states east of same; *Ulmus* and *Zelkova*, including elm logs or burls of any description; tobacco seed (*Nicotiana tabacum* L.), including all hybrids and varieties; living insects except the honey bee; pests, bacteria or fungous diseases destructive to vegetation, except for scientific purposes and under import permit.

Restrictions: Regulations restrict importations as follows: Potatoes from California must have a special fumigation certificate; potatoes from Pennsylvania, West Virginia and Maryland, special certificate stating potatoes were grown in an area free from potato wart disease; nursery stock (except prohibited conifers), forest products, stone and quarry products, etc. from New England, special certificate covering freedom from brown-tail and gypsy moth, and also from Japanese beetle from districts in which that insect occurs; chestnuts and chinquapin of the genus *Castanea*, all species, hybrids or horticultural varieties, unless accompanied by a certificate, issued and signed by an authorized officer of the country of origin, to the effect that the stock covered by the certificate originated in a district free

from the chestnut bark disease, that the said disease has not been present in the district for at least 10 years, and that the stock has been inspected and found free from the disease; peach trees, peach roots, nectarine roots, nectarine trees or any kinds or varieties of trees or shrubs grafted or budded on peach or nectarine roots from the United States of America are prohibited, unless each importation is accompanied by a certificate issued and signed by an authorized officer of the United States Department of Agriculture, or a state Department of Agriculture, to the effect that the stock covered by the certificate originated in a nursery which has been inspected by an authorized inspector and that the phony peach disease is not known to occur either in the nursery or within one mile of its boundaries; and, further, that each tree or root contained in the shipment has been examined by the said inspector and is free from the peach borer (*Synanthedon* (*Aegeria*) *exitiosa* Say).

Corn and broomcorn, including all parts of the plant, all sorghums and sudan grass from the states of Connecticut, Indiana, Kentucky, Maine, Maryland, Massachusetts, Michigan, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Vermont, Virginia, West Virginia and Wisconsin prohibited, except that broomcorn for manufacturing, clean shelled corn and clean seed of broomcorn may be imported from states mentioned if accompanied by a certificate of inspection, issued by an authorized official of the Federal or State Department of Agriculture and stating freedom from European corn borer; also, during the period June 1 to December 31, cut flowers and entire plants of chrysanthemum, aster, cosmos, zinnia and hollyhock, and cut flowers or entire plants of gladiolus and dahlia, except corms and roots thereof without stems, oat and rye straw as such or when used as packing, celery, green beans, beets with tops and rhubarb from the states of Connecticut, Maine, Massachusetts, New Hampshire, and Rhode Island may be imported from the states mentioned, provided each shipment is accompanied by a certificate signed by an authorized official of the Federal or State Department of Agriculture, stating freedom from infestation by European corn borer.

"In the case of seed potatoes, each container must have a Certified seed potato tag attached issued by the official certifying agency in the State of origin."

W. N. Keenan, Secretary, Destructive Insect and Pest Act Advisory Board, Department of Agriculture, Ottawa, Canada.

STATE REGULATIONS

Filing of Certificates in Other States

In order to ship nursery stock into the following states, it is necessary to file duplicate inspection certificates:

Alabama
Arkansas
Delaware
Florida
Georgia
Illinois
Indiana
Iowa
Kansas
Kentucky
Maryland
Massachusetts
Michigan
Minnesota
Mississippi
Missouri
Nebraska
New Jersey
New Mexico
North Carolina
North Dakota
Ohio
Oklahoma
Pennsylvania
Rhode Island
South Carolina
South Dakota
Tennessee
Texas
West Virginia
Wisconsin
Wyoming

Filing of Bonds

Bonds of $1,000 are required in the state of Idaho.

Tennessee requires a bond of $5,000 where trees are planted by outside nurserymen under contract to prune and spray for a period of years.

Payment of Fees

A few of the states charge fees to out-of-state nurserymen before they will permit them to ship stock into their state. Some states which do not normally charge fees will do so, however, if another state charges their nurserymen fees. Other states charge no fees, regardless of what other states charge their nurserymen. In some states it is necessary to purchase shipping tags in order to ship into that particular state. Still others have fees for dealers and agents. Some of these fees must be paid but in some cases they may be eliminated by reciprocal agreements. For instance, State A charges a fee of $5.00 to outside nurserymen and State B charges a fee of $10.00. By this reciprocal agreement, nurseries in State A may ship stock into State B by paying a fee of $5.00, the same as charged by State A. In like manner, the fee may be remitted altogether as concerns nurseries in states where no fee is charged to outside nursery firms.

Connecticut charges no fees to nurserymen in other states. Therefore, it is possible for Connecticut nurseries to do business in nearly all of the states without payment of any fees. The only exceptions are as follows:

Idaho (for charges see page 24).
Kentucky charges $5.00 for nurserymen; agents and dealers, $5.00.
Montana charges $15.00 for general nursery stock; $10.00 for ornamentals only; $5.00 for perennials and bulbs.
New Mexico—Nurserymen, $10.00.

State shipping tags are required and will be furnished at shippers' expense by the following states:

Arkansas—Cost $2.00 per 100 tags.
Florida—Cost $3.24 per 100 tags.
Georgia—Cost $1.00 per 100 tags.
New Mexico—Cost $1.25 per 100 tags.

Fumigation

All deciduous nursery stock subject to the attack of San José scale must be fumigated with hydrocyanic acid gas and labeled with a certificate or affidavit stating that this has been done, before it will be allowed to enter the state of Florida.[1]

State Quarantines on Account of European Corn Borer

Since the repeal of the federal European corn borer quarantine in 1932, many states have established quarantine regulations for protection against this insect. Some of these have revoked their quarantines. Prohibited or restricted articles are: corn, broomcorn, sorghums, Sudan grass (debris, cobs and parts of plants except clean shelled corn and seeds) aster, chrysanthemum, gladiolus, dahlia (cut flowers or entire plants, except bulbs or tubers without stems), beans in the pod, beets with tops, rhubarb, celery, oat and rye straw, cosmos, zinnia and hollyhock (cut flowers or entire plants).

This class of plants and plant material is rarely shipped by nurserymen with the exception of hardy chrysanthemums and hollyhocks. Special certificates showing freedom from infestation are necessary for these if they are to be shipped into the following states:

Arizona	Kansas	South Carolina
Arkansas	Maine	South Dakota
California	Nebraska	Tennessee
Colorado	Nevada	Utah
Florida	New Mexico	Vermont
Georgia	Oklahoma	Washington
Idaho	Oregon	Wyoming

Special Inspection and Certification of Raspberry Plants

In an attempt to control mosaic and allied diseases of raspberry plants, certain states require two summer inspections, one in June and the other a month later, after all mosaic plants discovered at the first inspection have been removed. If the plants are then free from mosaic diseases, a certificate to that effect may be granted. The following states require this special inspection and certification for shipping raspberry plants:

Illinois	Minnesota	Pennsylvania
Indiana	Missouri	Tennessee
Massachusetts	New York	Vermont
Michigan	North Dakota	Wisconsin

Because of the oriental fruit moth, all varieties and species, including the flowering forms and fresh fruits, of almond, apple, apricot, cherry, chokecherry, nectarine, peach, pear, plum and quince trees, or parts thereof, and the containers that have been used to hold such plants or parts thereof, are prohibited from entering Colorado and Utah.

[1] Fumigate all host plants of San José scale with hydrocyanic acid gas, at the standard dosage, or thoroughly scrub in a solution of fish oil soap at a dilution of one lb. of soap to three gal. of water immediately before shipment into Florida. Such stock entering Michigan must bear certificate of fumigation.

Taking and Transportation of Evergreen Trees or Foliage

This subject is covered by Section 1695c of the 1935 Supplement of the General Statutes. In addition to the provisions of the following law, it is necessary to have the material inspected and certified if it is gathered within the gypsy moth quarantined area and is to be transported outside of said area. (See page 6 for gypsy moth quarantine).

If the material is to be moved out of the quarantined area, it must be inspected by one of the Federal inspectors listed on page 8 and 9.

Section 1695c. Taking and transportation of evergreen trees or foliage. (a) No person shall take from the land of another the whole or any part of any pine, spruce, hemlock, fir or other evergreen tree with needle-bearing branches thereon, or any Kalmia latifolia, commonly known as mountain laurel, or any ferns, vines or foliage branches of trees or shrubs, without having in his possession the written permission of the owner or lessee, or his duly authorized agent, of the land from which such material was taken, and the presence in transit on any highway or in the possession of any common carrier of an amount greater than twenty pounds of the above commodities shall be prima facie evidence of a violation of the provisions of sub-section (b). (b) No person shall take from the land of another the whole or any part of any pine, spruce, hemlock, fir or other evergreen tree with needle-bearing branches thereon, of any Kalmia latifolia, commonly known as mountain laurel, or any ferns, vines or foliage branches of trees or shrubs, to be sold or offered for sale as a commodity, without having obtained and filed with the town clerk of the town in which such land is situated, the written permission of the owner or lessee, or his duly authorized agent, of the land from which the same was taken. Each bale, box, package or load containing more than twenty pounds of any commodity or commodities described in this section, transported upon the highway or offered for transportation to any common carrier, shall be legibly marked by tag, stencil or otherwise to indicate the name and address of the owner or lessee of the land from which such material was taken and the name and address of the person who gathered the same. The presence in transit, either upon the highway or in the possession of any common carrier, of any such bale, box or package not so marked, shall be prima facie evidence of a violation of the provisions of this section by the person in possession, or, if in the possession of a common carrier, by the consignor of such bale, box or package. (c) Any tree warden or officer authorized to serve criminal process may enforce the provisions of this section and of section 6131 and may inspect and weigh any bale, box or package containing such material, but the provisions of this section shall not be construed as authorizing any officer to stop or impede the progress of any train or electric car of any common carrier upon which such material may be in transit. No provision of this section shall be construed to apply to any tree, shrub or plant in transit from or growing in any commercial nursery. (d) Any person who shall violate any provision of sub-section (a) shall be fined not less than ten dollars nor more than fifty dollars. Any person who shall violate any provision of sub-section (b) shall be fined not less than fifty dollars nor more than one hundred dollars for each offense. The owner, occupant, person or agent in charge of the land as such authorized agent, or such person as he may command to assist him, may arrest any person violating any provision of this section, and forthwith take such person before such competent authority, who shall, upon complaint of the prosecuting officer, try such person. The owner, occupant, person or agent in charge of the land, arresting any person pursuant to the provisions of this section shall be entitled to the fees allowed by section 2280 to constables for similar services, which fees shall be taxed as costs by the court before which the trial is held. (e) Justices of the peace shall have jurisdiction in prosecutions for violation of the provisions of this section.

Individual State Regulations

Alabama. Out-of-State Nurseryman's Non-Citrus Certificate. This certificate covers non-citrus stock grown outside the State of Alabama and is issued upon the filing of a copy of a satisfactory inspection certificate (issued to the applicant and signed by the inspection official of the state wherein stock is grown) with the Division of Plant Industry, accompanied by a registration fee of ten dollars ($10.00).

Agent's Certificate. This certificate can be obtained only through the principal for whom the agent is to solicit orders, on the payment of a fee of one dollar ($1.00) to the Division of Plant Industry. An agent's certificate may be issued through either a nurseryman or a dealer. This certificate expires on September 30, the end of the fiscal year for which it is issued.

Dealer's Certificate. This certificate covers stock handled by one who grows no stock, but buys and re-sells nursery stock. A list of all nurseries from which a dealer will buy stock during the ensuing shipping season must be filed with the Division of Plant Industry, accompanied by a registration fee of ten dollars ($10.00), and if said list is satisfactory, a dealer's certificate may be issued. This certificate expires on September 30, the end of the fiscal year for which issued.

Reciprocal agreement on fees for nurserymen and dealers but not for agents.

B. P. Livingston, Chief, Division of Plant Industry, P. O. Box 220, Montgomery, Ala.

Arizona. All nursery stock and plant products entering Arizona through the United States mails or transported in any manner shall be prominently labeled, showing (a) name and address of consignor; (b) name and address of consignee; (c) certificate of inspection; (d) locality where grown, and (e) contents of shipment. Common carriers shall not deliver to consignee any shipment of nursery stock or plant products until inspected by the State Entomologist or his agent and a certificate of release issued in each case to the common carrier and to the consignee. Postmasters are required to forward all parcels of nursery stock or plant products to the nearest Post Office Inspection Station, and cannot forward from these stations to point of destination any parcel of nursery stock or plant product unless accompanied by an inspected plant shipment tag.

All trees or plants showing crown gall shall be prohibited entry into the State of Arizona. In those shipments or lots in which more than 50 per cent of the individual trees or plants of any one kind or variety are found infected and visibly affected by crown gall, the entire lot of that kind or variety shall be refused admittance into the State of Arizona, and shall be immediately sent out of the State, or destroyed, at the option and expense of the owner or owners, his or their responsible agents.

Nursery stock, plants, or plant products, arriving in Arizona shall be free from paraffin wax or other covering which interferes with the careful examination of the same.

Grapevines or cuttings showing evidence of infestation by phylloxera are prohibited. If there is no visible evidence of infestation, grapevines or cuttings are admissible if accompanied by an official certification of one of the following treatments: (1) Complete submergence in water of 125-130° F. for three to five minutes. (2) Nicotine oil dip for ten minutes. (3) Methyl bromide fumigation.

Strawberry plants must be accompanied by an official certificate stating that they were grown in an area free of strawberry root weevil, and are free of any other insect pest or plant disease.

A quarantine prohibits the entrance of: peach, nectarine, almond, plum, or apricot trees or cuttings, grafts, scions, buds or pits, or trees budded or grafted upon peach stock from Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, Ohio, Indiana, Michigan, Illinois, West Virginia, Tennessee, North Carolina, Arkansas, Nevada, Florida, Mississippi, Kentucky, South Carolina, Alabama, Georgia, Oklahoma, and any other section in which peach yellows or rosette are known to exist.

Cut flowers and entire plants of chrysanthemum, aster, dahlia, and gladiolus (except corms, roots, bulbs or tubers without stems) and rhubarb must be accompanied by an official state or federal European corn borer certificate if originating in any of the infested states.

All species of hickory, pecan and walnut trees, and parts thereof, including cuttings, grafts, buds and scions are admissible from all states east of and including Montana, Wyoming, Colorado and New Mexico only under Arizona permit and treatment.

J. L. E. Lauderdale, State Entomologist, Box 2006, Phoenix, Ariz.

Arkansas. Reciprocal registration fees: Nurserymen shipping into Arkansas will be charged the same registration fee that the state in which the nursery is located would charge an Arkansas nurseryman shipping into that state. Nurseries having agents in Arkansas must pay a $5 license fee, and $1 for each agent, and the same bond, if any, as the shipping state requires.

Permit to be attached to each package: A permit-label must be attached to each package of nursery stock coming into Arkansas. The price in all quantities is two cents each.

Quarantines: Nurseries must refrain from shipping chestnut trees into Arkansas unless special arrangements have been made with the Arkansas Plant Board.

Permits subject to cancellation: Permits are subject to cancellation because of diseased shipments, or for failure of the nursery to carry out the Board's requirements.

Applying for permits: In applying for permits, send a copy of current certificate of inspection or dealer's certificate, a registration fee, if any, as indicated in the first paragraph, and two cents for each permit desired. (Unused permits are not redeemable). If nurseries will have agents in Arkansas, they should send one dollar for each agent's license and five dollars for nursery license.

Cut flowers or entire plants of chrysanthemum, aster, cosmos, zinnia and hollyhock, and cut flowers or entire plants of gladiolus and dahlia, except the roots, bulbs or corms thereof, without stems, cannot be shipped into Arkansas from the states of Connecticut, Indiana, Maine, Massachusetts, Michigan, New Jersey, New Hampshire, New York, Ohio, Pennsylvania, Rhode Island, Vermont, West Virginia or other states infested with European corn borer, unless they have been inspected by a State or Federal inspector and certified by same to be free from the European corn borer, and unless a certificate to this effect is attached to each container.

There are no requirements governing shipment of bulbs and herbaceous plants, except sweet potato, tomato, onion and cabbage plants.

Paul H. Millar, Chief Inspector, Little Rock, Ark.

California. All shipments of nursery stock, plants, seeds and similar material into the state of California must be marked in a conspicuous manner and place with the name and address of the shipper, the name and address of the consignee, and a statement of the contents of each package; also the name of the country, state or territory where the contents were grown.

Of several state quarantines, the following are of interest to shippers to California:

Quarantine Order No. 2 (new series) prohibits the entry into California of all chestnut and chinquapin trees, plants, grafts, cuttings, scions and nuts thereof from all states and districts east of and including the states of Montana, Wyoming, Colorado and New Mexico, on account of chestnut bark disease.

Quarantine Order No. 4 (new series) prohibits the entry into California of all trees, plants, grafts, cuttings or scions of all species and varieties of the cultivated filbert or hazelnut and American wild hazel (*Corylus americana*) from all states and districts east of and including the states of Montana, Wyoming, Colorado and New Mexico, on account of Eastern filbert blight.

Quarantine Proclamation No. 10, Pertaining to Citrus White Fly. The following plants are admissible (1) if completely defoliated at origin; (2) if certified same are field grown for at least one year immediately prior to shipment and have not been placed in a heated structure where white flies may exist or where plants from states listed above are grown or stored; or (3) if certified treated at origin by an approved method in an approved fumigation chamber:

Ailanthus spp. (Tree of Heaven)
Camellia spp. (Camellia or Tea)
Choisya ternata (Mexican Orange)
Diospyros spp. (Persimmon)
Gardenia spp. (Gardenia or Capejasmine)
Ilex spp. (Holly)
Jasminum spp. (Jasmine)
Ligustrum spp. (Privet)
Melia spp. (Chinaberry)
Osmanthus americanus (Devilwood)
Prunus caroliniana (Carolina laurelcherry)
Sapindus mukorossi (Chinese soapberry)
Syringa vulgaris (Common lilac)

Quarantine Proclamation No. 11 prohibits the entry into California of peach, nectarine, almond, plum or apricot trees or cuttings, grafts, scions, buds or pits of such trees; or any trees budded or grafted upon peach stock or roots that have been in a district where any of the diseases known as peach rosette, little peach and peach yellows are known to exist. The states known to be infected are as follows: Massachusetts, Connecticut, Rhode Island, New York, New Jersey, Delaware, Maryland, Pennsylvania, Virginia, West Virginia, North Carolina, Tennessee, Kentucky, Mississippi, Ohio, Michigan, Illinois, Indiana, Arkansas, Florida, South Carolina, Georgia, Alabama, Oklahoma and the District of Columbia.

Quarantine Order No. 12 (new series) prohibits the entry into California of all varieties and species of hickory, pecan, and walnut trees (*Hicoria* sp. and *Juglans* sp.) and parts thereof from all states east of and including the states of Montana, Wyoming, Colorado and New Mexico, on account of the pecan leaf casebearer and the pecan nut casebearer, except that bare-rooted trees, grafts, cuttings or scions are admissible if treated at origin in a manner and by method approved by the Director of Agriculture in a fumigation chamber which has first been approved by the Director or under written permit from the Director subject to treatment at destination in California.

Quarantine Proclamation No. 15 (revised) prohibits the entry of all host plants of the European corn borer unless inspected and certified by a Federal or State inspector.

Quarantine Proclamation No. 16. Because of the Colorado potato beetle, potato, eggplant and tomato plants from all other states except Nevada and Territory of Hawaii must be accompanied by an official certificate of the state of origin, certifying that they were grown in a district in which the Colorado potato beetle is not known to occur.

H. M. Armitage, Chief, Bureau of Plant Quarantine, Sacramento, Calif.

Colorado. Each package of nursery stock entering the state must bear a certificate of inspection signed by a duly authorized inspector in the state from which it was shipped. On arrival, shipments are turned over to the County Inspector, who, in turn, if they pass inspection, releases them to the consignee.

Quarantines prohibit the entrance of the common barberry.

Host plants of the European corn borer are prohibited unless inspected and certified by a Federal or State inspector.

Fruit stock is prohibited on account of oriental fruit moth except under certain regulations.

F. Herbert Gates, State Entomologist, Bureau of Plant and Insect Control, State Museum, Denver 2, Colo.

Connecticut. Nurseries are inspected annually, and nurserymen are required to register before July 1 of each year. If they fail to do so they are charged the cost of inspection. Dealers are given permits to sell if they purchase stock from certified nurseries. All stock entering this state and all stock transported within the state must bear a certificate of inspection, and transportation companies are subject to prosecution if they accept shipments without valid certificates. Nursery stock imported from foreign countries must be held unopened until an inspector arrives. Inspectors have the authority to inspect any stock at destination.

Quarantines regulate the shipment of all nursery stock and forest products, on account of the gypsy moth, and prohibit the shipment of all elms from the Dutch elm disease quarantined area.

R. B. Friend, State Entomologist, New Haven 4, Conn.

Delaware. Each shipper of nursery stock must file a copy of his valid certificate with the State Board of Agriculture. Each shipment must bear a copy of the certificate of inspection of the state of origin. All shipments must conform to Federal rules and regulations.

S. L. Hopperstead, State Board of Agriculture, Dover, Del.

Florida. In order to make shipments from other states into Florida, in compliance with the rules and regulations of the State Plant Board, a nurseryman from without the state should comply with the following: (1) File with the Nursery Inspector, Gainesville, Florida, a copy of his certificate of inspection, personally signed by the proper official of his state; (2) secure Florida permit tags by making application for same on form supplied by the Nursery Inspector with remittance to cover cost of same; (3) attach one, and only one, Florida permit tag to each package, box or bundle of nursery stock shipped into Florida. In club orders, one permit tag should be attached to each individual order, and one permit tag attached to the package containing the individual orders; (4) each permit tag is serially numbered. An invoice showing the name and address of consignor, name and address of consignee, kind and amount of nursery stock in the shipment, and number of the permit tag attached to the shipment should be mailed to the Nursery Inspector, Gainesville, Florida, on the day the shipment is made. An invoice is required for each individual order in a club order and also for the package containing the individual orders; (5) return *all* spoiled or mutilated permit tags to the Nursery Inspector, Gainesville, Florida, for cancellation; (6) return all unused permit tags when same become void; (7) fumigate all host plants of San José scale with hydrocyanic acid gas, at the standard dosage, or thoroughly scrub in a solution of fish-oil soap at a dilution of one pound of soap to three gallons of water, immediately before shipment into Florida; (8) plants showing signs of infestation or infection by an especially injurious plant pest will be prohibited entry into the State of Florida; (9) *all citrus trees and parts thereof are prohibited entry into the State of Florida from all other states and countries*; (10) bulbs may be sold and shipped into Florida without inspection and/or certification; (11) woody perennials, including palms and orchids, whether grown in greenhouse or field, must be accompanied by permit certificate when shipped into Florida; (12) plants and plant products which are hosts of the European corn borer must be accompanied by a valid certificate of inspection issued by a State or Federal inspector certifying the material to be free from the European corn borer.

For additional information, address:

J. C. Goodwin, Nursery Inspector, Gainesville, Fla.

Georgia. Out-of-state nurseries and dealers must file with the Director of Entomology a duplicate certificate of inspection issued by the official certifying agency of the state of origin; obtain Georgia nursery certificates to be attached to every bundle or container of nursery stock moved into or within the State of Georgia, and pay registration costs.

The Director of Entomology may enter into reciprocal agreements with the certifying agency of other states whereby (1) no registration cost will be required, and (2) only valid nursery certificates of the state of origin will be required. (3) And any other reciprocal agreement that the Director may approve, for out-of-state nurserymen and dealers who otherwise qualify under these regulations; provided, that the inspection standards of that state are satisfactory to the Director and that such state will permit Georgia nurserymen and dealers, who otherwise qualify, to ship nursery stock into their state, without being required to pay a registration or permit fee and that only valid Georgia nursery certificates will be required.

Host plants of the European corn borer are prohibited unless inspected and certified by a Federal or State inspector.

C. H. Alden, Director of Entomology, Atlanta, Ga.

Idaho. No person, firm or corporation outside of Idaho shall sell nursery or floral stock by agents within the state without first applying to the Department of Agriculture for an annual license, according to the following schedule: Class A: Persons, firms or corporations doing a gross business in Idaho of over $200.00 per annum must pay an annual license fee of $15.00 and $1.00 annual license fee for each agent. If any fruiting plants or cuttings, grafts, scions, buds, fruit pits, or other seeds of fruiting plants are sold, they must furnish the Department of Agriculture with a $1,000 bond covering the sale of such stock. Class B: Persons, firms or corporations doing a gross business of $200.00 or less in Idaho per annum must pay a $5.00 annual license and $1.00 annual license fee for each agent, but no bond is required. All shipments into the state must show name of shipper, locality where grown, variety of nursery or floral stock. All nursery and floral stock shipped into the state must be inspected upon arrival, and when neither the shipper nor receiver has an Idaho license there is a destination inspection charge at the rate of 10 per cent of the invoice value of the shipment. An inspection certificate tag must be attached to all shipments.

State quarantines exclude the entrance of all five-leaf pine, currant, gooseberry, poplar, willow, peach, nectarine, prune, almond or other trees worked on peach stock and all pits, cuttings, buds, or scions grown in a district where peach yellows or other detrimental diseases exist.

Permits for entry must be secured from the Bureau of Plant Industry and accompany the shipment before any currants or gooseberries can be shipped into the state. The eight northern counties are designated as a blister rust control area from which currants, gooseberries and five-leaf pines are excluded. Host plants of the European corn borer are prohibited unless inspected and certified by a Federal or State inspector.

Wilson Kellogg, Director of Plant Industry, Boise, Idaho.

Illinois. Outside nurserymen and dealers in nursery stock, wishing to ship nursery stock into Illinois or to solicit business through agents in Illinois, are required to send to the office of the Horticultural Inspection Supervisor a duplicate copy of their certificate of inspection personally signed by their State Inspector. Those employing agents are required to apply to the Horticultural Inspection Supervisor for a permit to employ agents in Illinois and for a permit for each agent so employed before he engages in the business of soliciting orders for nursery stock. All agent's permits must be renewed annually after July 1. All outside nurseries are required to file a complete list of all agents in this state after that date.

All nursery stock entering the state must bear a valid State or Federal certificate of inspection, the names and addresses of the consignor and consignee, and a statement of the nature of the stock.

Transportation companies receiving stock without certificate of inspection must report the fact to the Department of Agriculture and must either return the stock to the consignor, hold it for inspection, or send it to the Department of Agriculture for inspection. Any person receiving nursery stock without certificate in this state is required to notify the Department of Agriculture and not to use the stock nor let it pass from his possession until it has been inspected or released by the Department of Agriculture and expenses incurred paid.

Stock shipped into Illinois in violation of a State or a Federal quarantine is destroyed or returned to the consignor or otherwise disposed of at the discretion of the Department.

H. F. Seifert, Horticultural Inspection Supervisor, Division of Plant Industry, Glen Ellyn, Ill.

Indiana. Nursery stock entering or shipped within the state must bear an official inspection certificate and give the names of both the consignor and consignee. All out-of-state nurseries must file with the State Entomologist a copy of their valid inspection certificate before shipping stock into the state. Each dealer and agent selling or soliciting sales of nursery stock in Indiana must pay $1.00 and obtain a license from the State Entomologist.

Frank N. Wallace, State Entomologist Department of Conservation, Indianapolis, Ind.

Iowa. Copy of inspection certificate must be filed with and approved by the State Entomologist, and must accompany each shipment of nursery stock into the state. The State Entomologist may make reciprocal agreements with officials of other states regarding fee. Otherwise, the fee for out-of-state shippers from any particular state is the same as the fee charged Iowa nurserymen by the officials in that state.

Carl J. Drake, State Entomologist, Ames, Iowa.

Kansas. Nurseries are inspected annually and all certificates expire on June 1, following date of issue. Nurserymen in other states wishing to ship nursery stock into Kansas must file with the Secretary, Kansas Entomological Commission, State House, Topeka, Kansas, printed copies of their current certificates of inspection, and attach a copy of this certificate to each package of nursery stock shipped to a separate destination.

Dealers in nursery stock must register with the Kansas Entomological Commission, pay a fee of $5, and receive a dealer's license. Agents selling or soliciting orders for nursery stock must register with the Commission and receive and carry an agent's license.

Provision for reciprocal agreement or fee.

Special inspection and certificate required on raspberry plants.

No fees required from Connecticut nurserymen.

Quarantine No. 4 prohibits the entry of all susceptible plants from states infested by the European corn borer unless inspected and certified by a Federal or State inspector.

GEO. W. KINKEAD, Secretary, Entomological Commission, Topeka, Kans.

Kentucky. Kentucky nurseries are inspected annually and certificates are issued when stock is found free of dangerous pests. A required permit is issued to a non-resident nurseryman, doing business in Kentucky, when a copy of his local certificate of inspection is filed and a fee of $5.00 is paid.

Agents and dealers must file credentials annually, including names of nurseries, nurserymen or persons represented, and on payment of a fee of $5.00 are issued a permit. Agents soliciting orders must carry their permits to show prospective buyers, county officials or agents of the State Entomologist, on demand.

W. A. PRICE, State Entomologist, Lexington, Ky.

Louisiana. Out-of-state nurserymen are no longer required to obtain Louisiana permit tags and file a copy of their certificates of inspection with us. All that is required is that each shipment of nursery stock entering Louisiana have attached proper valid certificate permit tag as issued by the proper officials of the state of origin.

W. E. ANDERSON, State Entomologist, Department of Agriculture, Baton Rouge, La.

Maine. All nursery stock shipped into this state from any other state, country or province shall bear on each box or package a certificate that the contents of said box or package have been inspected by a duly authorized inspecting officer, and that said contents appear to be free from all dangerous insects and diseases. Nurserymen, dealers or other persons residing or doing business outside of the state, desiring to solicit orders for nursery stock through agents in this state shall file a certified copy of their original state certificate with the State Horticulturist, and shall keep on file with the State Horticulturist a list of agents and representatives in the state. The State Horticulturist, or his competent assistants, may inspect at the point of destination all stock coming into the state, whether under certificate or not and, if such stock is found to be infested with any injurious insects or plant diseases, the State Horticulturist shall cause it to be destroyed or returned to the consignor at the consignor's expense, if he shall so elect.

Host plants of the European corn borer are prohibited unless inspected and certified by a Federal or State Inspector.

STANLEY L. PAINTER, State Horticulturist, Augusta, Me.

Maryland. Nurseries are inspected twice each year. Nursery stock coming from blocks that show evidence of San José scale must be hand-inspected to eliminate visibly infested stock. Shipments entering the state must bear certificates of inspection, besides names of consignor and consignee. A duplicate certificate should be filed with the State Entomologist. Reciprocal agreement with other states.

Maryland has quarantines designed to protect the state against the Japanese beetle, white pine blister rust and potato wart. These regulations are similar to the Federal quarantines and are administered in coöperation with the Federal authorities.

ERNEST N. CORY, State Entomologist, College Park, Md.

Massachusetts. All growers and agents who sell nursery stock for delivery within the state must have a grower's certificate or an agent's license, and a copy of such certificate or license must accompany each car, box or package of stock shipped or delivered. Agents must apply to Director, Division of Plant Pest Control and Fairs, Boston, Mass., and file list of nursery firms from which they purchase stock before receiving agent's license. Authority is granted to inspect at destination all stock entering the state and, if found infested, it may be destroyed, treated or returned to the consignor at his expense.

Federal quarantine prohibits *Ribes* from entering the state except under permit.

Q. S. LOWRY, Acting Director, Division of Plant Pest Control and Fairs, 24 State House, Boston, Mass.

Michigan. All nurseries are inspected at least annually. Annual fees are: nurseryman, $15; native tree dealers, buyers and dealers in nursery stock, $10; growers and dealers in perennial plants, $2; agent's permit, $1.

Out-of-state nurseries must file copies of their inspection certificates and need not obtain licenses unless they operate through Michigan agents, in which case each must have an out-of-state license, for which the annual fee is $15. Each Michigan agent for an out-of-state nursery must carry an agent's permit (Fee, $1.00) transferable from one agent to another within the period of one year. Agents must qualify either by experience or by a written examination before receiving permit. All native trees and shrubs not grown in a regular nursery require that a special native tree tag, furnished at cost by the Commissioner of Agriculture, be attached to each plant in addition to inspection.

Special inspections and certificates required on raspberry plants.

Provision for reciprocal agreements.

Federal control area permits required for currants and gooseberries.

C. A. Boyer, Director of Orchard and Nursery Inspection Service, Department of Agriculture, Lansing, Mich.

Minnesota. All shipments must be accompanied by a valid certificate of inspection on the outside of each package. A copy of this certificate must be filed with the State Inspector before nursery stock is shipped into the state. No filing fee is required unless the nurseries are located in states which charge Minnesota nurseries, dealers or agents a fee for shipping stock into such states. A fee is charged in the same amount as such states charge Minnesota nurseries, dealers or agents. All agents and salesmen are required to carry an agent's registration card. This is issued without fee only through the firm which they represent.

Minnesota Quarantine No. 6 requires that all raspberry plants shipped into Minnesota must be accompanied by a valid certificate showing that the plants have been inspected and found apparently free from mosaic and other virus diseases. A special affidavit signed by the shipper may be accepted in lieu of such certificate on each package.

The term "nursery stock" includes all wild and cultivated trees, shrubs, perennial vines, small fruit plants, perennial roots, rhizomes, herbaceous perennials, cuttings, buds, grafts and scions for or capable of propagation. A certificate of inspection is not required for greenhouse or housegrown plants, bedding plants, herbaceous annuals, vegetable plants, bulbs, corms and tubers.

All nursery stock for shipment into Minnesota must comply with the requirements of quarantines promulgated by the Federal Bureau of Entomology and Plant Quarantine.

T. L. Aamodt, State Entomologist, University Farm, St. Paul, Minn.

Mississippi. Nurseries wishing to ship nursery stock into Mississippi must file with the State Plant Board a copy of their certificate of inspection personally signed by their State Entomologist. No nursery permits are required, but each shipment must have attached a valid Connecticut nursery certificate tag.

All plants capable of defoliation must be defoliated. Plants infected with root knot (caused by nematodes), crown gall, or showing any insect pest or disease or markings thereof, must not be shipped into Mississippi. The movement of all trees and plants commonly known as nursery stock, consisting of palms and woody perennials

(including budwood and scions), strawberry plants and kudzu plants, which do not have attached thereto a proper certificate tag issued by the Connecticut State Entomologist, is prohibited.

There is no quarantine on Connecticut peach stock, as the phony peach disease has not been reported from Connecticut.

Each agent representing a nursery is required to register with and obtain an agent's certificate from the Plant Board before selling, delivering or taking orders for nursery stock in Mississippi. Stock shipped to nursery agents for delivery in Mississippi must be packed in individual packages, and each of these accompanied by a Connecticut permit.

R. P. Colmer, Chief Inspector, State College, Miss.

Missouri. Non-resident nurserymen and nursery dealers are required to secure a "nursery agent's certificate" for each agent operating in Missouri. Each package of nursery stock entering the state must bear the names of both consignor and consignee, statement of contents, and a certificate showing that the stock therein contained has been inspected where grown by a duly authorized inspector and found to be apparently free from dangerously injurious insect pests and plant diseases. Transportation companies are not permitted to deliver nursery stock unless so labeled.

Any nurseryman of any other state, territory or district of the United States who desires to ship "nursery stock" in Missouri, shall make application to the State Department of Agriculture for a Missouri "nursery permit certificate," and shall include with his application a duplicate copy of his state nursery inspection certificate. Upon receipt of same in proper order, the State Entomologist will issue a "nursery permit certificate" without charging any fee whatsoever.

Annually, on or before October 1, each nurseryman or nursery dealer shall file with the State Entomologist a complete, confidential list of his agents operating in Missouri. Upon the approval of the State Entomologist there will be issued without charge, for each such qualified nursery agent, a "nursery agent's certificate." This applies to non-resident nurserymen and nursery dealers, as well as to those in Missouri. Supplementary lists shall be filed after October 1, as additional agents are appointed. Each nursery agent shall keep his certificate in his possession, while acting in such capacity, to be shown upon request by any prospective customer or authorized representative of the State Entomologist.

J. Allison Denning, State Entomologist, Jefferson City, Mo.

Montana. All nursery stock brought into the state must be unpacked and inspected at one of the following designated quarantine stations: Anaconda, Billings, Bozeman, Butte, Culbertson, Dillon, Glasgow, Glendive, Great Falls, Hamilton, Havre, Helena, Kalispell, Lewistown, Miles City, Missoula, Noxon, St. Regis, Troy.

Nurseries are required to pay an annual license fee of $15 for general nurseries; $10 for nurseries handling ornamentals only and $5 for those handling only perennials and bulbs.

Quarantines exist against the following:

No. 2-A. Common barberry plants from all states.

No. 3-A. Shipment or movement into or within the state of any cultivated black currant plants.

No. 7-B. Entry into or movement through Montana of any black locust plants, or untreated black locust products from the territory east of the eastern boundary of the states of Montana, Arizona, Idaho, and Utah; also the State of Washington and from the Dominion of Canada.

Also all five-leaved pines, currant and gooseberry plants as specified in Federal Quarantine No. 63, and as amended.

GEORGE L. KNIGHT, Chief, Division of Horticulture, Missoula, Mont.

Nebraska. Non-resident nurserymen, dealers or other persons wishing to ship nursery stock into Nebraska must file a duplicate certified copy of their original certificate with the State Department of Agriculture and Inspection. If this certificate is approved by the Department of Agriculture and Inspection, they will be issued a permit allowing them to ship nursery stock into this state during the period that such original certificate, issued by the state in which they reside or are doing business, is in force. A $10 fee is charged for the non-resident dealer's or nurseryman's permit, except for nurserymen in states that do not charge a fee of Nebraska nurserymen. Nurserymen in those states will not be charged a fee to ship into Nebraska. Each shipment of nursery stock coming into the state must be plainly and legibly marked in a conspicuous place with a statement showing: (a) the name and address of the consignor; (b) the name and address of the consignee; (c) the general nature of the contents; (d) the name of locality where grown and (e) a certificate of inspection from the proper official of the state, territory, district or country from which it was shipped. All agents selling nursery stock or soliciting orders for nursery stock for any nurseryman or dealer, located either within or without the State of Nebraska, shall be required to secure and carry an agent's permit. The fee for this permit is $1.

Any prohibited insect pest or plant disease, plant product or other substance or thing, brought into the state in violation of any regulation of the State Department of Agriculture and Inspection or any Federal quarantine, shall at the expense of the owner be either destroyed, returned to the consignor or otherwise disposed of, as the Department of Agriculture and Inspection may direct.

Quarantine against the European corn borer prohibits all the usual host plants entering the state from the infested areas, unless accompanied by a certificate of inspection showing freedom from the pest.

L. M. GATES, Entomologist, State Department of Agriculture and Inspection, Lincoln, Neb.

Nevada. All nursery stock entering the state must bear, on each car, bale or package, a copy of a valid official inspection certificate, and names of consignor and consignee. Transportation companies shall not deliver nursery stock lacking such certificate.

Quarantines regulate shipment of all plants subject to infestation by the European corn borer from infested states.

Any of the articles covered by this quarantine will be admitted into the State of Nevada, providing each shipment or lot is accompanied by a certificate signed by an inspector of the U. S. Bureau of Entomology and Plant Quarantine certifying that the material contained in the shipment or lot has been disinfected or treated under the supervision of such inspector in such a manner as to eliminate all risk of transmitting the European corn borer; or a certificate signed by a duly authorized inspector of the state of origin, certifying that the material has been treated under official supervision in a manner and by a method approved by the Nevada State Department of Agriculture. Such certificate shall set forth the material used, the dosage schedule, period of exposure, date and place of treatment. At time of shipment a duplicate copy of said certificate shall be mailed to the address below.

GEORGE G. SCHWEIS, Director, Division of Plant Industry, Box 1027, Reno, Nev.

New Hampshire. All nursery stock entering this state must bear on each container a copy of a valid inspection certificate.

Quarantines prohibit the entrance of currants or gooseberries into any part of the state, except an area in the northernmost part of the state, beginning with the towns of Stratford, Odell, Millsfield and Errol; and prohibit entry of plants susceptible to attack by the gypsy moth, the brown-tail moth, and the satin moth from infested regions into uninfested territory, except with the proper certificate.

W. C. O'KANE, Deputy Commissioner of Agriculture, Durham, N. H.

New Jersey. All nurserymen, dealers, or other persons residing or doing business outside of New Jersey and desiring to ship nursery stock into New Jersey, shall file once each year with the New Jersey Department of Agriculture, previous to shipments, a signed copy of their original current, resident state certificate of inspection. Ship-

ments into the state must be accompanied by a certificate of inspection of current date, or copy thereof, attached to each car or parcel. It shall be the duty of all carriers to refuse for transportation within the state all stock not accompanied by a certificate of inspection. All stock coming into the state may be detained for examination, wherever found, by the Chief of the Bureau of Plant Industry, and if found to be infested with any insects or plant diseases, injurious or liable to become so, will be destroyed.

It shall be the duty of every nurseryman, or other person who imports plant material of any kind from without the state, and every transportation company or other carrier for hire that brings plant material from without the state for delivery to any person, persons, firm, or corporation within the state, to notify the Chief of the Bureau of Plant Industry of such shipment prior to, or within 24 hours after, its arrival. Such notice shall state the kind, the quantity of plant material, the name and address of the shipper, the date of shipment, and if from a foreign country the name of the country or district in which the shipment originated, the port of entry, and the approximate date of arrival at said port.

Strawberry plants may be brought into the State of New Jersey or moved from point to point within the state only after they have been inspected by an official state inspector of the state in which they were grown, and found to be free from the so-called red stele disease (*Phytophthora* sp.) also known as red core, brown stele or brown core. All shipments of strawberry plants must have attached thereto a copy of a special certificate issued by the proper state official of the state of origin, attesting that the plants contained in the shipment were inspected by an official state inspector and found to be free of the red stele disease.

Harry B. Weiss, Chief, Bureau of Plant Industry, State Department of Agriculture, Trenton, N. J.

New Mexico. Nurserymen in other states desiring to ship nursery stock into New Mexico must file a copy of their certificate of inspection signed with pen by the proper official, with a filing fee of $10, and secure a permit-certificate bearing the facsimile signature of the Deputy Inspector, which must accompany each shipment of nursery stock into the state. Tags may be purchased at the following prices:

50 tags	$1.00	200 tags	$2.00
100 tags	1.25	500 tags	4.25

Quarantines prohibit shipments of white pines and *Ribes* on account of white pine blister rust.

Red cedars (*Juniperus virginiana*) are prohibited on account of danger of introducing cedar-apple rust. Host plants of European corn borer are prohibited unless inspected and certified by a Federal or State inspector.

R. F. Crawford, Plant Quarantine and Regulatory Office, State College, N. M.

New York. Nursery stock cannot enter the state or be moved within the state unless a valid certificate is attached issued by the New York State Department of Agriculture and Markets, or by the state in which the shipment originated. Transportation companies and all persons bringing nursery stock into the state from other states, must send notice to the Department of Agriculture and Markets. Blanks will be furnished for such notices. An exact copy of the certificate must be attached to each package sent by mail. Stock received from abroad or from other states unaccompanied by a valid certificate of inspection must not be unpacked or distributed until after inspection or release by the Department of Agriculture and Markets.

Quarantines prohibit the entrance of Christmas trees and woody greens from New England except from those areas lightly or not infested by gypsy moth (Federal certificates must accompany shipments from the lightly infested area); of raspberry plants unless apparently free from mosaic diseases and so certified after two inspections and the removal of all diseased plants, as is practiced in New York State. Currants and gooseberries cannot be grown in certain pine-growing areas of the state and permits must be obtained to ship them into the state. Name and address of consignee must be given in application.

A. B. Buchholz, Director, Bureau of Plant Industry, Department of Agriculture and Markets, Albany, N. Y.

North Carolina. Nursery stock may enter the state only when shipments bear a valid copy of the official nursery certificate of state of origin, a copy of which must be filed with the State Department of Agriculture.

Quarantines prohibit the entrance of five-leaf pines and *Ribes* except in accordance with Federal regulations.

C. H. Brannon, Entomologist, State Department of Agriculture, Raleigh, N. C.

North Dakota. Shipments of nursery stock into the state must bear a certificate of inspection showing that the stock has been inspected and found free of injurious insects and plant diseases. Copy of said certificate must be filed with the office of the State Entomologist of the North Dakota Agricultural College, Fargo, North Dakota.

J. A. Munro, State Entomologist, Agricultural College, Fargo, N. D.

Ohio. Non-Resident Certification — Nurserymen, dealers, or agents residing or doing business outside the State desiring to ship or transport nursery stock into this State, shall, upon filing a certified copy of their original state certificate with the Director of Agriculture, obtain a certificate permitting such person to ship or transport nursery stock into this state. Each dealer within the state shall obtain annually a dealer's certificate, by furnishing an affidavit that he will buy and sell only inspected stock and will maintain with the Secretary of Agriculture a list of all sources from which he obtains nursery stock. Each affidavit shall be accompanied by a fee of $10. Each agent soliciting orders for nursery stock shall file annually a statement that he will sell only inspected stock, and pay a fee of $1. He shall carry an agent's certificate and a copy of the certificate held by his principal. Each shipment entering the state shall be accompanied by a tag or poster giving an exact copy of the valid certificate of inspection. Altered certificates are prohibited.

Raspberry plants must be inspected twice and certified as being free from virus and other diseases.

John W. Baringer, Chief, Division of Plant Industry, Department of Agriculture, Columbus, Ohio.

Oklahoma. Each nurseryman or dealer outside of the state must file a duplicate copy of his valid certificate with the Chief Inspector and apply for an Oklahoma Out-of-State Permit. A copy of the certificate of the state of origin must be attached to each shipment of nursery stock consigned to Oklahoma. "Nursery stock" as defined by Oklahoma regulations includes plants of all kinds: florist stock, corms, scions, grafts, etc., except vegetable plants and roots and bulbs used for the production of food. Oklahoma and Connecticut are on a reciprocal fee basis; neither state charges the other a permit fee.

Clyde A. Bower, Chief, Division of Entomology and Plant Industry, Oklahoma City, Okla.

Oregon. Shipments of nursery stock entering the state must be plainly marked with names and addresses of both consignor and consignee, name of state, territory where grown, nature of contents, and be accompanied by a valid nursery inspection certificate of the state of origin. All shipments are inspected. Nurserymen's licenses are required ONLY of nurserymen who have a place of business in said state. A fee of $1.00 is required for each agent operating in the state. A flat $10.00 license fee is required of dealers.

Quarantines prohibit entrance of hazel and filbert trees, all chestnut and chinquapin trees or cuttings or scions of said nut trees from eastern states.

Plants of the genus *Rubus* will be admitted when accompanied by a certificate signed by the proper state inspection officer of Connecticut, certifying that all of the plants in said lot or shipment were

taken from a planting which had received field inspection during the growing season and found to be free from virus diseases.

Grapevines and cuttings accepted when accompanied by certificate that shipment is from an area or premises free of phylloxera, or has been given one of the approved treatments.

Host plants of the European corn borer must be accompanied either by a treatment or inspection certificate signed by an inspector of the Bureau of Entomology and Plant Quarantine, or by the proper official of the state of origin.

All narcissus bulbs coming into the state must carry a certificate certifying that all of said bulbs were given the spring and fall inspection and found free from nematode and greater bulb fly or had received the required treatments for nematode and/or bulb fly.

Frank McKennon, Chief, Division of Plant Industry, Department of Agriculture, Salem, Ore.

Pennsylvania. Each nurseryman from outside of the state must file with the Director of the Bureau of Plant Industry a duplicate copy of his valid inspection certificate, signed in person by the state inspection official in charge, and supply a statement giving the exact acreage of nursery stock he is growing, as well as the acreage being grown for him under contract. Upon compliance with these regulations a certificate is issued that must be received before stock is shipped into the state. Dealers are granted certificates on application and receipt of a statement from each that he will buy stock only from nurseries holding valid certificates of inspection. Agents soliciting for the sale of nursery stock in the state must obtain and carry agent's duplicate certificates. All shipments of nursery stock entering the state will be rejected unless accompanied by certificates of inspection.

Special certification is required for raspberry plants.

T. L. Guyton, Director, Bureau of Plant Industry, Harrisburg, Pa.

Rhode Island. All stock entering the state must bear a valid official certificate of inspection, but is subject to further inspection and may be destroyed or returned to the consignor if found infested. Agents must obtain agent's licenses, on stating where they expect to purchase their stock. State of origin certificate to be filed.

Ribes or white pines can be shipped into the state or planted in certain parts of the state only on permission. Planting of black currant is prohibited.

Frank S. Leaver, Acting Administrator, Division of Entomology and Plant Industry, State House, Providence, R. I.

South Carolina. File valid certificate of state of origin with South Carolina State Crop Pest Commission.

Quarantines prohibit the entrance of five-leaf pines, currants and gooseberries, except when shipped in conformity with Federal regulations. Citrus stock is allowed to enter only by special permit. Fumigation of host plants of San José scale is required. Host plants of European corn borer not allowed entry without inspection and certification.

All peach and nectarine roots, and peach and nectarine trees with roots, and all other stock budded or grafted on peach or nectarine roots, will not be permitted to enter the state unless accompanied by a state certificate showing that (1) the stock was grown in a county in which no phony peach disease has been found, or (2) that the nursery and its environs within a mile have been inspected and no phony peach disease found, and (3) that each plant has been hand-inspected after digging and found free of infestation by the peach borer.

South Carolina State Crop Pest Commission, Clemson College, S. C.

South Dakota. Out-of-state nurserymen may obtain a certificate permitting them to sell nursery stock within the state by filing a certified copy of their valid certificate with the Department of Agriculture, Pierre, South Dakota and paying a fee of one dollar. (Excepting that the fee may be omitted from states making no charge for a similar service to South Dakota nurserymen). Agents engaged in soliciting orders shall secure and carry an agent's certificate (fee, $1.00) bearing a copy of the certificate held by his principal. Dealers are required to obtain a dealer's certificate (fee, $10.00) and must purchase their stock from certified nurseries.

Host plants of the European corn borer are prohibited unless inspected and certified by State or Federal inspectors.

Norris M. Paulson, Director, Division of Plant Industry, Department of Agriculture, Pierre, South Dakota.

Tennessee. Out-of-state nurseries must file duplicate inspection certificates and reciprocal fee. Every shipment must bear a valid inspection certificate, and failure to comply with this requirement subjects the stock to confiscation. Nursery agents and dealers must file sworn statements on official Tennessee blanks, which will be supplied. Each agent operating in Tennessee, and each dealer or jobber, is required to secure a license. Nurserymen selling trees under contract to prune and spray the same for a period of years are required to take out a bond of $5,000 before selling trees under such special contract.

State quarantines prohibit the entrance of all varieties of barberry, except *Berberis thunbergi*. Other restrictions apply to the Japanese beetle, the European corn borer, gypsy moth, sweet potato weevil, pink bollworm of cotton, Argentine ant, Japanese camphor scale, white-fringed beetle, phony peach disease, and white pine blister rust. Peach and pecan seedlings are allowed entrance only by special permit for experimental purposes.

G. M. Bentley, State Entomologist and Plant Pathologist, Knoxville 16, Tenn.

Texas. No person, partnership or corporation may ship nursery stock into the state without first having filed with the Commissioner of Agriculture a certified copy of their certificate of inspection issued by the proper authorities in the state from which the shipment originates. Each box, bale or package of nursery stock from outside the state shall bear a copy of the certificate of the state in which it is originates. No charge is made to Connecticut nurserymen because this state does not charge Texas nurserymen a fee to ship nursery stock into Connecticut. Definition of nursery stock includes greenhouse plants or propagation stock, berry plants and cut flowers.

For further information as to other quarantines, communicate with

Walter T. McKay, Chief Entomologist, Department of Agriculture, Austin, Tex.

Utah. No person shall engage or continue in the business of selling within the state, or of importing into the state, any nursery stock without first having obtained a license. A license fee costs $10, but it is only charged if the nursery employs agents in Utah. All nurseries are inspected annually, and infested stock must be destroyed or otherwise treated as determined by the inspector. A certificate must be attached to each package, box, bale or car lot shipment. Nursery stock from other states must be held for inspection and release by Utah inspectors before distribution.

State quarantines prohibit the shipment of all fruit trees and their flowering varieties from eastern and middle United States on account of the oriental fruit moth; all pecan, Japanese walnut and hickory trees from all states, except California, on account of the pecan casebearer; and all plants susceptible to infestation by the European corn borer, unless inspected and certified by a Federal or State inspector.

Earl Hutchings, Supervising Inspector, State Board of Agriculture, Salt Lake City, Utah.

Vermont. All nursery stock entering the state must bear valid official inspection certificates and the names and post office addresses of both consignor and consignee.

Quarantines restrict the free movement of out-of-state shipments of uncertified raspberry plants on account of mosaic, leaf roll and

rosette, hosts of the European corn borer, and all uninspected and non-nursery grown trees and forest products on account of the gypsy and brown-tail moths.

M. B. Cummings, State Nursery Inspector, Burlington, Vt.

Virginia. Nursery stock shipped into Virginia must have attached to each package an official inspection tag or certificate issued by the state of origin. Inspection certificates of the state of origin need not be filed before shipping nursery stock into Virginia. Registration of out-of-state nurserymen to ship into Virginia is no longer required, except that nurserymen in states requiring Virginia nurserymen to pay registration fee shall be charged a $10.00 fee.

All agents operating in Virginia must register, the cost for each agent being $1.00. Make checks for registration payable to Treasurer of Virginia.

Nursery stock under the Virginia regulations includes trees, shrubs and vines, bush fruits, grapevines, whether cultivated, native or wild, and buds, scions and cuttings from such plants. Roses and other woody plants that are greenhouse grown, provided they are sold for outside planting, are considered nursery stock. Greenhouse plants, unless woody and field grown, are not included as nursery stock, and inspection certificates are not required, except as stated above. The same is true of herbaceous perennials and bedding plants.

G. T. French, State Entomologist, Richmond 19, Va.

Washington. No person, firm or corporation shall sell, solicit sales or distribute nursery stock without first obtaining a license to do so from the Director of Agriculture. The license fee is $5 for nurserymen who grow all the stock they sell, $15 for other nurserymen, dealers, brokers and landscape architects, and $1 for agents, salesmen and solicitors. However, the Director of Agriculture may enter into reciprocal agreements with other states, under which nursery stock owned by licensed nurserymen or licensed nursery dealers of such states may be sold or delivered in the State of Washington without payment of a license fee: *Provided*, that like privileges are accorded in such other states to licensed nurserymen of the State of Washington. All licenses expire July 1. All nursery stock entering the state shall have contents, names and addresses of consignor and consignee, and name of state, territory, or country where the stock was grown, plainly marked on each car, box, bale or package, also must have state of origin certificate attached. The state is divided into eleven horticultural districts with an inspector-at-large in charge of each district. Notice must be sent to one of these inspectors of any shipments arriving without the proper license certificate or labels, and the said inspectors are authorized to inspect such shipments and charge such fees as may be fixed by the Director of Agriculture.

Quarantines prohibit the entrance of currants, gooseberries, chestnut, chinquapin, hazel, filbert, and carriers of the European corn borer, peach yellows, and grape phylloxera.

Wm. H. Shaw, Supervisor of Horticulture, Olympia, Wash.

West Virginia. Plants commonly known as nursery stock (perennials exempt) are not to be shipped, given away or offered for sale in this state unless there is plainly attached a tag or statement certifying the plants have been inspected by a qualified officer of the state of origin and found to be free of dangerously injurious insects and plant diseases.

Nurserymen and dealers in nursery stock must be registered with the Commissioner before such plants are offered for sale. Non-resident nurserymen may register without cost by filing an application for registration, together with their current certificate of inspection. A non-resident dealer in nursery stock may register by filing an application for registration, executing a dealer's affidavit, and paying a fee of $15.00.

Registers are required to file the name of their agents or representatives operating in the state. Transportation companies may be required to report shipments of nursery stock violating these regulations.

J. B. McLaughlin, Commissioner of Agriculture, Charleston, W. Va.

Wisconsin. Each out-of-state nurseryman must file a valid certificate of inspection and obtain a state license before shipping stock into the state. Each car, or package, must bear certificate tags. Each agent selling nursery stock in the state must carry an agent's duplicate certificate bearing the same number and date as that of his principal. No fees are charged except for resident nurserymen.

Quarantines prohibit entrance of all barberry bushes, except Japanese barberry; nursery stock from gypsy moth infested areas except under Federal certificate; cranberry plants; raspberry plants unless certified to a special inspection for virus diseases.

E. L. Chambers, State Entomologist, Madison, Wis.

Wyoming. Each out-of-state nurseryman must file a valid certificate of inspection from the proper authority of his state, he then receives a license valid until the following July 1. Wyoming shipping tags are not necessary, provided shipments of nursery stock are accompanied by a tag or certificate of the state of origin stating that the material or the nursery has been inspected and found free from dangerously injurious insects and plant diseases. Reciprocal agreements.

Host plants of European corn borer from the infested territory shall bear, as a condition for entry into the State of Wyoming, a certificate signed by an inspector of the Bureau of Entomology and Plant Quarantine, United States Department of Agriculture, or by an authorized inspector of the state of origin, certifying that the material contained in the shipment or lot has been treated under the supervision of said inspector by approved method or methods in such manner as to eliminate all risks of transmitting European corn borer. Black stem rust quarantine prevents shipment of certain barberries into Wyoming.

GEORGE B. HARSTON, State Entomologist, State Department of Agriculture, Powell, Wyo.

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