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ANNUAL REPORT

for the

Year Ending October 31, 1942

Connecticut
Agricultural Experiment Station
New Haven

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[1] As of March, 1943. [2] On military leave. [3] In cooperation with the U.S.D.A.

CONTENTS

REPORT OF THE DIRECTOR

FOR THE

YEAR ENDING OCTOBER 31, 1942

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

JUST one year ago the Board issued a statement of policy to guide the Station as the Nation braced itself for the impact of war.

> "As the scientific servant of agriculture, how can the Station be of the greatest use? It seems clear that we should bend every effort, (1) to place in the hands of farmers the latest information that bears on efficient production, and on economy in the use of materials; (2) to find substitutes for materials that are short, ways to save spray materials and fertilizers, higher yielding varieties of crops, and (3) to maintain without serious interruption its fundamental research, upon which all future progress depends."

How the Staff have tried to carry out this policy is the central theme of this report. Naturally all have felt keenly the responsibility that rests on every citizen alike—to make the best use of his time and special skill. As public servants in the service of agriculture, we are especially mindful of our responsibility.

Fortunately, the functions of an Agricultural Station fit it ideally for such times as these. Its object and purpose is to increase the efficiency of agriculture. Thus, if its findings are sound and useful in normal situations, they become doubly valuable when more food must be produced with less labor and supplies. For this reason, no fundamental changes have been necessary in our program. True, some new problems have arisen and were attacked vigorously, but the greatest contributions have resulted from careful examination and reappraisal of what we already know—to the end that many contributions have been made to our wartime farming.

To save tires and gasoline, some outlying experiments have been omitted and the work done near the Station.

The Staff

Several of our staff have now entered the military services, and some have left for other reasons. Instead of our usual 130, we now number 100. However, by rearranging and taking on extra duties, we shall manage.

During the Station year under review the following military leaves have been granted:

Raymond R. Nichols, Station Sampling Agent, January 1, 1942
Alfonzo DeCaprio, Research Technician, March 22, 1942
M. F. Morgan, Chief of the Soils Department, April 16, 1942
Joseph Datillo, Laboratory Helper, May 5, 1942
Louis M. Roberts, Graduate Assistant, May 24, 1942
John Scarchuk, Research Technician, June 30, 1942
Arthur B. Ward, Gypsy Moth Scout, July 19, 1942
Alphonse Parente, Gypsy Moth Scout, August 1, 1942

Dr. Vickery is on part-time leave, connected with the blood plasma program of the Federal Government at Harvard Medical School.

Dr. Alfred J. Wakeman, Assistant Biochemist, retired June 30, 1942, after 30 years of service.

The following appointments were made:

Soils—Edward J. Rubins, M.S., April 16, 1942
Plant Pathology—George A. Gries, Ph.D. June 1, 1942
Biochemistry—Jane K. Winternitz, Ph.D., July 1, 1942

Station Buildings

The parasite laboratories in Britton Laboratory are now equipped and in full operation, filling a long need. The assembly hall in this building has proved of great usefulness. It is used not only for Station meetings, but by many groups of farmers and gardeners.

The greenhouse at Windsor has been moved and rebuilt.

Field Days

The usual Field Day at Mount Carmel Farm was omitted, it being felt that farmers were too busy and rubber too precious. The Strawberry Field Day and the usual Field Day at the Tobacco Substation, Windsor, were not held for the same reasons.

A special Sweet Corn Field Day was held at Mount Carmel for seed growers and breeders on September 10, 1942.

Progress of the Station's Work

ANALYTICAL CHEMISTRY

Most of the activities of this department are of a regulatory nature. Chief among them is the examination of fertilizers, feeding stuffs, foods, drugs and insecticides, as required by state statutes. An important factor in public welfare in peace times, these activities become even more so in times of stress. Dislocation of normal sources of supply, readjustments in manufacturing and distributing methods due to war regulations, and shortages of skilled labor bring about a situation that may result in irregularities or debasements in finished products. The interests of consumer and producer alike require continued alertness in regulatory matters at all times.

Except in the case of fertilizers, enforcement of the statutes is the responsibility of the Dairy and Food Commissioner. This department collaborates with him in the formulation of rules and regulations for carrying them out. A large amount of analytical work is done for other state agencies, notably the Storrs Experiment Station, the Commissioner on Domestic Animals and the State Supervisor of Purchases. Considerable time is given to the examination of biological specimens in cases of suspected poisoning of live stock. The department is also charged with the checking and certification of glassware for testing milk and cream by the Babcock method, and of thermometers used in the control of the pasteurization process in milk plants.

The work of the laboratory is reported each year in a series of Station bulletins, one on fertilizers, one on feeds and one on foods and drugs. Special reports on other matters are issued as occasion demands. These bulletins are mailed to people directly interested and to others on request.

Fertilizers and Feeding Stuffs

War regulations governing the manufacture and distribution of commercial fertilizers and feeding stuffs are reflected in the work of the department. More inquiries are received from manufacturers and others in regard to government orders on registrations, labelling and other features. Feed manufacturers are faced with the difficulty of maintaining nutritive values and guaranties for their mixed feeds with market conditions changing almost daily as regards the kinds and qualities of ingredients available for mixing purposes. Control officials are confronted with the problem of administering local regulations without imposing unnecessary burdens on industry in these difficult times.

Foods and Drugs

In the stress of war time some consumers become suspicious of foodstuffs that they buy and their fears are enhanced by rumors of malicious tampering with the food supply. Crystals of sugar in jellies, honey and maple syrup, salt crystals in preserved meat or fish products, particles of silica in products of vegetable origin, and harmless crystals of struvite, a natural

occurrence in canned fish, have all been innocent causes of apprehension on the part of consumers who mistook them for ground glass. In our experience over many years we can recall only two or three instances of glass in food products. Contamination of foods can happen by accident in the commercial processing or packing of foods, and it can also happen in the home.

Shortages of certain foodstuffs for civilian use, by reason of rationing or curtailment of imports, invite substitutions and "stretching". It is not new in food control experience to find our domestic vegetable oils marketed under the representation that they are imported olive oil, but such occurrences have been more common than usual during the past year.

So far as examination of market coffee submitted by the Dairy and Food Commissioner reveals, there is little adulteration at the present time. In practically all cases the article sold as coffee was found to be genuine. Mixtures of coffee with cereal, pea, bean or other vegetable products were labelled to show their true character. This is the consumer protection that the statutes provide. However the consumer may choose to stretch his reduced ration of coffee, he can be assured that the non-coffee materials just cited are not harmful, and he can let his own taste and his own idea of economy be his guide. The true coffee lover will probably elect to conserve his supply by reduced rations of the genuine article.

During the last war a method of "stretching" butter[1] was proposed, and received some local publicity. It consisted in mixing one pound of butter with a pint of milk to make two pounds of the mixture. The finished product differed from butter in that it contained over three times as much water and about one-half as much food solids per unit of weight. It was in fact "watered butter", its advantage being psychological rather than nutritional. The same economy would be effected by drinking the pint of milk and serving half portions of butter.

Protection of Foods and Drugs in Wartime

In World War I the services of this department were made available to the State Food Administrator for such laboratory work as he might require. Recently the food and drug control officials of the northeastern states have formed an emergency council for the duration of the war and have evolved a cooperative plan for control of food and drug supplies that may become damaged through gas bombs, fires and other incidents of war. The plan provides for mutual aid between the several states in the New England group, New York and New Jersey, in regard to inspection service, laboratory facilities and schools of instruction. Members of the department have taken part in the council discussions during its formative stages, and our laboratory has been placed at the disposal of the emergency group.

Live Stock Poisoning

Considerable attention has been given in recent years to the investigation of live stock poisoning, much of it in collaboration with the Department

[1] Page 210, Bulletin 201 of this Station.

of Animal Diseases at Storrs. This service is appreciated by stock owners and is often an aid to the veterinarians consulted. It cannot, of course, restore the losses already incurred, but in many instances it has determined the probable causes and suggested measures to prevent further losses.

The farm refuse pile or dump appears to be one common hazard that can be abated. Discarded paint or insecticide containers and other poisonous waste should be disposed of where animals cannot have access to them. Animals like to lick freshly painted surfaces so those within their reach should be covered with non-poisonous paint that does not contain lead. Fertilizer bags, and water in which the bags are washed, should be placed out of reach of their inquisitive noses.

Plants poisonous to live stock have been frequently described in literature. Widely distributed over the country, some are found in this State. Clear indications of plant poisoning are difficult to obtain by laboratory examinations of animal specimens, but in several instances visits to pastures have afforded convincing proof that plants have caused the death of farm animals. This is particularly true of water hemlock, one of our most poisonous wild plants.

BIOCHEMISTRY

Asparagine

ASPARAGINE has been known for nearly 150 years to be a component of plant tissues, especially of young seedlings. In recent years it has assumed considerable importance as a constituent of certain of the culture solutions used by bacteriologists, especially for the preparation of tuberculin. Several hundred pounds of asparagine are used in this country every year for the production of tuberculin used in the testing both of man and of cattle for the presence of tuberculosis. Hitherto by far the greater part of the asparagine employed has been imported from abroad. War conditions have stopped this source of supply.

Accordingly, attention has been given here to the preparation of asparagine. Preliminary study revealed the fact that the emergency was more acute than had been at first realized. Asparagine is most advantageously prepared commercially from the seeds of a species of lupine which it was necessary to import. Although existing stocks of seed have been adequate, or nearly so, since the outbreak of the war, the time is rapidly approaching when all available stocks will have been exhausted.

Attention has thus been turned to species which are suitable for asparagine production on a large scale and which are, or could be, grown in this country. Last year we published a preliminary account of experiments on a laboratory method for the preparation of asparagine from the seeds of white lupine and soy bean. Since this appeared, a species of blue lupine (*Lupinus angustifolius*) grown in Florida has proven equally, if not more, satisfactory under properly controlled conditions than the imported white lupine. This work has gone far towards solving the problem of asparagine production in the United States.

Plant physiologists have repeatedly investigated the conditions under which asparagine is synthesized in the plant. It has long been held that the substance occupies a key position in the chemical reactions that take place after nitrogen is absorbed by the roots in the form of nitrate or ammonium salts, and is transformed into protein in the tissues and ultimately in the seeds of the plant. Through these investigations in plant metabolism we are making steady progress towards understanding how the plant prepares the proteins that are used as food by man.

Isocitric Acid

Citric acid has many uses in present-day industry, quite aside from the preparation of soft drinks. It is an important substance in connection with the production of plastics and of other munitions of war. The chief acid of limes and lemons, as well as of other citrus fruits, citric acid is widely distributed in plant tissues. It is found in the leaves of many plants, often in considerable quantity, and is an important component of cured tobacco leaf. In Russia much attention has been given in recent years to the production of citric acid from tobacco waste. The chief sources in this country are the lemon crop of the Southwest and the fermentation industry.

From the standpoint of the plant biochemist also, citric acid is very important since present-day speculations consider it an intermediate substance in the series of chemical reactions concerned with the respiration of living cells. During the past year, as part of a program of study of the organic acids of leaves, an investigation was made of the leaves of *Bryophyllum calycinum*, a common greenhouse plant. This plant was selected because it has long been known to possess an unusual type of organic acid metabolism as a result of which the acidity varies between wide limits according to the time of day the leaves are examined.

A preliminary examination of the organic acids of Bryophyllum leaves soon showed that, in addition to the malic acid and citric acid that are almost invariably found in leaf tissues, there was present a large proportion, amounting to 11 per cent or more of the dry weight of the leaves, of an organic acid different in properties from any that had hitherto been encountered here. This was finally identified as the rare substance, isocitric acid. Previously it has been found in small quantities only in blackberry fruit and in the leaves of some of the cereal grains. Thus not only has a plentiful source of this substance been revealed, but the observation was made, quite by chance, at a time when isocitric acid had begun to assume considerable theoretical significance as the result of investigations in other laboratories both in this country and abroad.

Furthermore, it became apparent that the early descriptions of the organic acids of Bryophyllum leaves, as well as those of allied species in the botanical family Crassulaceae in which an unusual organic acid had been found, were in error. The unusual acid had been supposed to be an isomeric form of malic acid and had been called crassulacean malic acid. Its occurrence had provided a unique and quite inexplicable anomaly since all theoretically possible isomers of malic acid were known and were unlike the so-called crassulacean malic acid.

The investigation has thus led to two quite unforeseen results: the discovery of a rich source of the rare substance, isocitric acid, and the solution of an old and puzzling problem which has hitherto stood in the literature with an entirely erroneous explanation.

Histidine

Most proteins, when boiled with strong acid, yield, among the other products of their decomposition, three basic amino acids, histidine, arginine and lysine. Two of these amino acids, histidine and lysine, have long been recognized as being essential in the nutrition of rats and presumably also of man, and investigations a few years ago in Wisconsin have shown that the third, arginine, is essential in the nutrition of chickens. These three substances are accordingly of great importance, and a knowledge of the amounts yielded by any given protein is necessary, particularly at the present time when diets both of animals and of man are frequently restricted owing to war conditions.

The basic amino acids have also attracted much attention from investigators chiefly concerned with theoretical problems, since the chemical and physical properties of the proteins from which these substances are derived are to a considerable extent determined by the relative proportions and the arrangement of the basic radicals in the protein molecule.

The Department of Biochemistry has devoted a great deal of time during the past 15 years to the study of the basic amino acids in proteins and, during the past year, has paid particular attention to histidine. An entirely new method to prepare this rare and interesting substance has been developed which, it is hoped, will greatly reduce the cost of commercial production. The work is now being extended towards the development of a method for the analytical determination of histidine with greater accuracy than has been easily possible by current methods.

Hemoglobin, the most important protein of red blood cells, contains an unusually large proportion of histidine, but it has hitherto been held that the hemoglobins derived from different animal species are very similar with respect to the proportion of histidine each of them yields. By the use of the new method, this has been shown not to be the case. The hemoglobin of man has been found to be appreciably richer in histidine than is the hemoglobin of the horse or of the sheep, a chemical fact which is in agreement with early observations in the literature on the marked differences in crystalline shape of these three kinds of hemoglobin.

Nutrition

Throughout the history of the preparation of diets for nutrition investigations, the question of the choice of a suitable protein has been of the greatest importance. For many types of experiments, the chief problem is to obtain a nutritionally adequate protein in sufficiently pure form. Casein has been almost exclusively used. But when it is necessary to limit the intake of phosphorus, casein is not suitable and a protein devoid of this element must be chosen. Lactalbumin is probably most commonly employed as an alternative but its preparation in a pure form is a tedious and expensive process.

Among the most readily available substitutes are the vegetable globulins, of which edestin from hemp seed is the classic example. This globulin has been studied in detail for many years, especially by Osborne since 1892, and has been widely used in feeding experiments on laboratory animals with considerable success.

During the past few years, government restrictions on the trade in hemp seed have made it essential to secure some substitute for edestin. A survey two years ago led to a study of the seeds of plants of the family Cucurbitaceae since these seeds are always available at fairly low cost and, in some regions, the seed of pumpkins is a waste product of the canning industry.

Globulins were prepared for nutritive studies from two varieties of watermelon seeds, one of cucumber and two of squash seeds. In all cases, well-crystallized proteins were obtained in excellent yield. When foods that contained any one of these globulins were supplied to young growing rats, the growth response was essentially the same as with edestin, indicating that any one of the five proteins could serve as a substitute for edestin in experiments that require a phosphorus-free type of protein.

These growth studies have again emphasized what has been known for many years, that there are limitations in the use of vegetable globulins for the growth of the young rat. None of these proteins is as satisfactory as lactalbumin or casein. The rats consume more food per gram of weight gained and it is clear that the food mixture is not completely satisfactory. The reason for this is obscure and should be studied further.

ENTOMOLOGY

Insecticides

The production of food required during the present war emergency demands efficient protection against insect pests. This is particularly essential in view of increasing shortage of insecticides, equipment and labor. The situation may be met in several ways, but our investigations have emphasized the use of proper diluents for dusts, the adjustment of dosages and schedules to give adequate control, and the development of new insecticides.

Diluents of Dusts

Laboratory tests made early in 1942 confirmed the findings of other workers that considerable differences exist among diluents or carriers for dusts. Tested in the laboratory with pure ground derris root (4 per cent rotenone), the diluents fell into three groups: (1) a pyrophyllite, which was most effective, (2) flaky talc and slate dust, which were somewhat less effective and (3) fibrous talc and a clay, which appeared to have a detrimental effect on the toxic ingredients.

The pyrophyllite and clay were selected for field tests in which all treatments were made according to schedules in use by growers. By use of

a dosage series it was possible to compare the dosage required for an equal degree of control.

In every case substantially more rotenone was needed when the derris was diluted with clay than when diluted with pyrophyllite. This varied from two and a half times in the case of flea beetles to five times in the case of Mexican bean beetle larvae. In other words the substitution of pyrophyllite for clay as a diluent would reduce the rotenone required by these amounts and still provide the same control.

Dosages of Dusts

The effect of reducing the dosage of insecticides on control was studied on several crops. In every case the "standard" concentration was the equivalent, based on the above work, to the one in common use by growers. The tests were conducted by applying dusts in a series of concentrations, usually from double to one-eighth the standard. All were field tests, using the schedules of treatment suggested for growers. All rotenone and pyrethrum-bearing dusts were diluted with pyrophyllite.

Except in two cases the reduction in concentration to one-half the standard caused only a small loss in control. In the case of the European corn borer and cabbage worm the loss was substantial. The corn borer is not controlled adequately in seasons of severe infestations, such as that of 1942, and of course a reduction in dosage leaves even less adequate control. The cabbage looper was the most abundant pest on cabbages; it is not especially well controlled by rotenone-containing dusts.

Orchard Insect Control

The so-called "di-nitro" compounds look very promising in orchard pest control. The European red mite, much in evidence in 1942, frequently becomes injuriously abundant on apple trees during the summer and has been difficult to suppress at this time. Careful tests with sprays containing a cyclo-hexylamine salt of di-nitro-cyclo-hexyl-phenol showed this to be an efficient insecticide for summer use under the experimental conditions. During the last two years other materials have been tested, and we now have several that may become useful to the orchardist. Cooperation with the federal Bureau of Entomology and Plant Quarantine in the investigation of the effect of sprays on the population of this mite and its predators in apple orchards has continued with interesting results. The use of sulfur sprays has decreased the abundance of predatory mites and the abundance of the European red mite has consequently increased. Other factors are involved in the increase in population of the latter, and the predatory mites do not always check its abundance sufficiently.

Control of aphids in our apple orchards was obtained with dormant sprays of 2.4 di-nitro-phenol and 3.5 di-nitro-o-cresol. A delayed dormant spray of lauryl thiocyanate was likewise effective.

In apple maggot control the application of rotenone dusts has given gratifying results. We have been able to reduce the infestation in a

heavily infested orchard to a point where fruit of commercial value is now produced. Unfortunately the supply of rotenone has been reduced by war conditions to such an extent that orchardists may have to resort to other materials for the control of this insect.

Any reduction in the number of spray applications required to produce a crop of good fruit is of particular importance at the present time. The development of a good sticker would go far in this direction. Oils with aluminum salt safeners and stickers have given preliminary results of some promise. A combination of lime sulfur and lead arsenate with soybean or wheat flour and manganese borate has also proven to be a good apple spray for certain varieties.

Fruit Moth Parasite Distribution

The distribution of *Macrocentrus ancylivorus*, a parasite of the oriental fruit moth, was carried out throughout the State in cooperation with the Connecticut Pomological Society during the summer. One hundred and ninety-three colonies, totalling 32,160 individuals, were sent to 81 peach growers. Better facilities for the production of this parasite have been provided in the new Britton Laboratory.

Some Insect Pests of Vegetables and Fruits

European Corn Borer

To serve as a basis for judgment in determining the feasibility of using insecticides and to facilitate choosing planting dates to avoid corn borer damage, observations were made at Mount Carmel during the summer of 1942 on 14 plantings of sweet corn made in sequence from April 17 to July 16.

The results indicated that such corn planted in April would have been practically unmarketable without insecticidal treatment. Corn planted in early May could have been treated profitably in view of the continued high market price for borer-free corn. Corn planted the last two weeks in May and the first two weeks of June were relatively free from serious borer injury. That planted the last two weeks of June would have been profitably dusted unless the abundance of the corn ear worm, which is not affected by the treatment for corn borer, rendered the ears unmarketable. It would probably not have been profitable to treat the corn planted in July.

Studies of the effect of individual insecticide treatments in the standard schedule, using dual-fixed nicotine dust four times at intervals of five days, were completed. As in 1941, no one treatment appeared to be more or less effective than any other. Treatment of ears only produced promising results and required less labor and material than the standard schedule.

Dual-fixed nicotine dust and derris dust were tested in dosage series. At low concentrations derris dust was the more effective, but at higher strengths the nicotine dust was superior.

Comstock's Mealybug

Surveys of apple and pear orchards throughout the State indicate the presence of this insect, a new pest of fruits in Connecticut, in at least seven apple orchards and three pear orchards. Parasites obtained from the federal Bureau of Entomology and Plant Quarantine were colonized in five different localities. In the original infestation, parasites (principally *Allotropa* species) have become so numerous that the infestation of mealybugs has now dropped below the danger point. Recoveries have been made in other localities although the parasites have not as yet become numerous enough to reduce the infestations.

Japanese Beetle

This insect continues to be a very injurious pest. Defoliation of trees, shrubs and some herbaceous plants was severe in many sections of the heavily infested areas. These include most of the towns in the southern parts of Fairfield and New Haven Counties and about 100 square miles in Hartford County. Numerous apple, elm and horse chestnut trees were completely defoliated in Rocky Hill and Wethersfield.

Injury to economic plants is more severe in areas of heavy infestation with much open grassland and relatively little woodland. The adults have been injurious to the fruits of peach, plum and some varieties of early apples in Fairfield County, and the grape foliage has been extensively injured in the generally infested areas. The larvae continue their destruction of untreated lawns and other turf areas.

Colonization or spotting of the milky disease of Japanese beetle larvae throughout Connecticut continues. During the summer and until November 1, 1,403 plots, mostly one-half acre in size, were placed throughout Hartford, New Haven and Fairfield Counties; 856 in Hartford, 254 in Fairfield and 293 in New Haven County. Experimental plots show the presence of the disease among the grubs in increasing quantities.

Soil and Grassland Insects

Scarabaeid Larvae

White grubs, larvae of certain scarabaeid beetles, were abundant and injurious to grasslands during the past season. The larvae of *Aphonus castaneus* Melsheimer, not heretofore reported as a pest in this State, were injurious in some localities. It is possible that this insect, normally not abundant, has been favored by the dry seasons preceding 1942 and increased to outbreak population levels in localized areas. The annual white grub, *Cyclocephala borealis* Arrow, although not so abundant as in the past, destroyed turf on a golf course in Orange. The oriental beetle, *Anomala orientalis* Waterhouse, injured lawns in and around New Haven. It has spread into North Haven. The Japanese beetle is discussed under fruit insects.

An investigation of the effect of temperature on the toxicity of different doses of lead arsenate to Japanese beetle grubs has given interesting results. As the soil temperature drops from 87°F. to 57°F. the effect of this insecticide becomes markedly delayed. In relation to Japanese beetle

Inspection, Quarantine and Control Operations

The enforcement of quarantines and the inspection and control operations, for which the State Entomologist is responsible, have been carried out as efficiently as possible under the present conditions.

The nursery inspectors examined 339 nurseries with a total area of 4,650 acres and found the usual number of insect pests and diseases. The war has shut off the importation of foreign nursery stock so none of this material was received in Connecticut.

The gypsy moth work included the usual scouting and control operations and the type mapping of forested areas in the State. Twenty infestations were sprayed, 5,650 pounds of lead arsenate being used. The forested areas in New London, Windham and parts of Tolland Counties have been mapped to date. This has markedly decreased the amount of scouting necessary in this area. Many of the men employed in gypsy moth work have gone into the defense industries and the armed forces. This has reduced the personnel to less than half its normal number. The infestation in the State was remarkably light in 1942, and no serious defoliation by this insect was found.

The three apiary inspectors examined every known apiary in the State this year. American foul-brood is still the greatest hazard to successful bee keeping. The honey crop, an important item at this time, was of lower grade than usual, due to the production of a large amount of black honeydew "honey".

Certain plant materials have to be inspected because of federal quarantines. Under Japanese beetle quarantine regulations 2,756,840 plants were inspected and certified. Gypsy moth quarantine certificates numbering 3,877 were issued, covering the shipment of nursery stock and forest and quarry products. In relation to the corn borer quarantine 2,365 certificates of inspection were issued. Seed inspection certificates totalling 166 were also issued. Most of this seed is shipped to Central and South America.

The Dutch elm disease situation is serious. The federal Bureau of Entomology and Plant Quarantine is confining its efforts to the examination of elms in a broad zone bordering the edge of the quarantined area. This area includes Fairfield County and the southern part of Litchfield County. Hence the zone of federal operations, about 30 miles wide, extends from the northwest corner of the State to the mouth of the Connecticut River. In that zone the federal bureau has removed and destroyed the diseased trees in an attempt to delay the spread of the disease eastward. In the towns along the eastern edge of the quarantined area the diseased elms are being removed by town tree wardens and private citizens.

In southwestern Connecticut (Greenwich, Stamford, Darien and Norwalk) a large number of diseased trees, many of them dead, are still standing. Local authorities and private citizens are being urged to remove and destroy them. Unless this is done, the infection will probably increase next year. All of this Dutch elm disease control work is hampered by a shortage of funds, labor and equipment.

BULLETIN ON THE DIPTERA

The first of a series of bulletins on the Diptera, or the flies, of Connecticut, written by well-known authorities, is being printed and should be available for distribution soon. This includes a section on the morphology of flies and a section on the taxonomy of the Tipuloidea, the most primitive group of families.

FORESTRY

A Wood-Burning Unit for Household Furnaces

NOT SINCE Colonial times has wood assumed the importance it holds today in the homes and production plants of a fighting America. Anticipating the fuel oil shortage, the department, in cooperation with the Yale School of Engineering, designed a wood-burning conversion unit for household furnaces and prepared Bulletin 463 describing its construction and use. The project was part of a study of the utilization of native woods which has been in progress at the Station for several years.

The conversion unit that has been perfected is directly adaptable to most coal and oil furnaces. With the exception of a cast-iron door, the entire unit can be made of non-strategic materials such as fire brick, fire-resistant cement and tile. The essential features are a fuel chamber, which may be built in front of or at the side of the furnace, and a connecting flue between the chamber and the furnace ash pit. Green as well as seasoned wood can be utilized, and softwoods as well as hardwoods.

Rainbow Experimental Forest

In 1901 the Station established an experimental forest near Rainbow in the town of Windsor. The tract consists of 120 acres of coarse sandy soil, so poor it had been abandoned for farming. The field was laid out into plots, and planted to many species of conifers and hardwoods, alone and in combinations, and at various spacings. This was the earliest experiment of its kind in this country.

A report on the plantation was issued in 1924 as Station Bulletin 262. Preparation of a follow-up was interrupted by the hurricane of 1938, which destroyed part of the forest. Bulletin 464, "The Rainbow Forest Plantations", recently issued, contains descriptions of the hurricane damage and brings the history of the plantings up to date.

Not only the success or failure of the many different kinds of trees are described, but their yields of timber and the effects of thinning, pruning and systems of management. Notes are given on 20 species of conifer and hardwood trees which have been found best suited for forestry planting in sandy soils of the State. These include red and white pines, Norway and white spruces and black locust. Taken up in some detail is white pine, considered a valuable component of any stand, but especially on sandy soils on which few good timber species will grow.

The Quality of Plantation-Grown Wood

For over 50 years the Station has encouraged the planting of conifers in state forests, on municipal water sheds and on private land. Much information on tree growth and management has accumulated, based on these plantings and those at Rainbow. The trees are old enough now to be tested for quality of timber. Accordingly, wood from these plantation-grown conifers is being examined by this Station in cooperation with the Yale Forestry School. A report will be published soon.

Distribution of Forest Planting Stock

Although not a war project, forestry planting is an important conservation measure. In view of the growing importance of forest products in the national economy, farmers and other woodland owners should consider undertaking tree planting so long as labor is available for the purpose.

As in past years, the Station distributed forest planting stock at cost in the spring of 1942. The total number of trees shipped was 406,000. Of this number, 48 per cent were white and red pines; 36 per cent were Norway and white spruces; 12 per cent were Douglas fir, and the balance were of various species. This demand for stock was somewhat less than in previous years. This was believed partly due to war conditions, but also to the fact that considerable stock from out of the State was distributed here at very low prices under the Agricultural Conservation Program. It is anticipated that the planting stock now on hand at Windsor will be disposed of in the spring of 1943, and that thereafter the distribution of forest planting stock will be carried on by other agencies than this Station.

Control of White Pine Blister Rust

During the season of 1942 the Station has continued cooperation with the U. S. Department of Agriculture in the control of this disease. Control work was carried on in nine towns under the supervision of the Station with labor paid from funds provided by towns, municipalities, state forester and individuals. A total of 77,790 wild Ribes and 69 cultivated Ribes were removed and destroyed from 33,511 acres of control area. This gave protection to 7,524 acres of white pine. In addition, eight pine-producing nurseries were given protection by the removal of 6,418 wild Ribes and 87 cultivated Ribes from 3,175 acres of control area.

GENETICS (PLANT BREEDING)

Hybrid Field Corn

With food rationing the order of the day, corn becomes increasingly important since it is a principal ingredient of the dairy cow's ration, and is used in the feeding of poultry, sheep, beef cattle, hogs and horses, not to mention man. The nation's corn crop was estimated this year at 3,175,154,000 bushels. This is the highest annual yield on record and was produced on a smaller acreage. This result may be attributed in part to the extensive use of hybrid corn as well as a good season.

Connecticut has played a major role in the creation of this new high-production corn. The first seed of double-crossed hybrid field corn was produced in 1917 at the Experiment Station farm at Mount Carmel. A field of commercial seed was grown in 1921 at Clinton, Conn. Prior to this, open-pollinated types were the only varieties grown. By 1941 the use of cross-bred seed corn had increased to 32,511,000 acres, or about one-third of the total area grown.

Nearly 500 combinations resulting from crossings of new Connecticut inbreds and the best of western inbreds were grown in 1941 in observation fields at Mount Carmel. From these preliminary trials the most promising hybrids were chosen to be grown in a replicated yield test the past season. Results of this test, together with recommendations by farmers who tried them in different sections of the State have been summarized in a report on grain and ensilage corn available on request from the Station. Outstanding ones are Cornell 29-3, Ohio M15, Illinois 219, Wisconsin 700 and Iowa 939 for early grain, and U. S. 13, 35 and 44, Ohio 92 and Illinois 972 among the late grain and ensilage varieties.

Many new inbreds derived from eastern varieties are in the process of selection, as well as numerous backcrossed lines from older lines that have certain desirable features combined with undesirable ones that can be eliminated. The production of usable single crosses depends upon the development of more vigorous and productive inbreds that also have the best combining ability.

Because of the small seed and uneven growth of inbred corn, seed production by crossing two inbreds to produce a single cross hybrid has not been as popular with seed growers as the double cross. The latter results when two different strains of single hybrids are cross pollinated. Seed of a single cross hybrid, however, may result in offspring of equal merit to those of the double cross. For growers who wish to produce seed by this simpler and less expensive method of single crossing, trials have been made and seed will be available in small quantities for 1943 planting.

To obtain a more complete test of single crosses, the best inbreds from a selected list have been crossed in all possible combinations. In subsequent years these will be grown in grain-yield tests. From the results it will be possible to predict the best three-way and double cross combinations.

Hybrid Sweet Corn

The main objective has been to develop a series of hybrids of sufficiently different maturity so that the whole list may be planted at the same time and corn can be picked throughout the season. This has for the most part been achieved. Ten years ago there was only one good well-adapted single cross in sweet corn. This was Golden Cross Bantam, which was too late for many of the Connecticut growers. Now Spancross (C13×4), Marcross (C13×6), Carmelcross (P39×C13), Lee (P39×C27) and Lincoln (P39×C23) have been added in successive seasons earlier than Golden Cross Bantam. In 1941 more than a million pounds of seed of these Connecticut hybrids was produced.

In the season later than Golden Cross, Wilson (C31×C87) and Golden Stowell (C53×C65) are available. Both are productive hybrids and are suitable for canning. Having one ear per stalk facilitates treatment to control the corn ear worm in these hybrids.

Just as hybrid field corn has made possible a record corn crop on one of the smallest acreages grown, so in sweet corn the hybrid varieties enable farmers and gardeners to produce all the sweet corn needed on a smaller acreage. It also saves considerable time and effort to be able to make only one planting of several good hybrids. In the series now widely used for this purpose all but one were developed here. A single planting made about the middle of May will escape much of the damage caused by a serious pest, the European corn borer. This is an important consideration, especially for the home gardener.

All Connecticut hybrids are resistant to bacterial wilt. Some are resistant to smut, and the breeding of smut-resistance has begun on susceptible varieties. The quality of certain Connecticut hybrids will continue to be improved.

The color of several white varieties is being changed to the more popular yellow. These include Vanguard, Early Pearl, Stowells Evergreen and Late Mammoth. An inbred secured from Golden Mammoth, C95, gives very productive hybrids that may have a place in the list of ensilage varieties, thus serving to increase the sugar content of silage.

Squash

Yankee Hybrid summer squash in 1942, as in several previous years, retained its record of being the earliest and most productive commercial variety. Several new combinations of inbreds had appeared to be earlier and more productive in 1941 and some third-generation selections from hybrid lines were earlier than Yankee Hybrid. Tests of these hybrids and inbreds the past two years were interrupted by a new soil-borne disease called foot-rot.

In the summer squash trials at Windsor in 1941 every plant of every variety and strain died prior to completing its normal life span. In 1942, 36 different strains and combinations including those planted in 1941 were grown on the same plot of land for the purpose of selecting or detecting any lines that might be resistant to this disease. Only a small percentage of the plants died in 1942 and there was no apparent difference between strains as to their resistance to the disease.

This same disease appeared in the breeding plots at Mount Carmel in 1942 killing all of the plants in more than 75 per cent of the different lines, and many of the plants in all lines. No lines escaped infection. Breeding work will be greatly delayed until control measures are developed for the disease or until resistant lines are found. Station pathologists are actively studying the problem.

The search for a plant with sterile pollen was continued. One line was found which may be useful for this purpose. The pollen of this line is

apparently so full of oil that it sticks together and will not adhere to the legs of pollen-carrying insects. Such an inbred would greatly facilitate the production of first-generation hybrids, as it would eliminate the necessity of removing the stamens.

Tomatoes

Preliminary picking tests of tomato lines developed at the Mount Carmel farm were made in 1942. One new strain will be given more extensive tests in 1943 and some seed will be released for grower's trials. This new strain is deep red in color, meaty and slightly earlier than the standard types. It averages 5 to 6 ounces in weight.

Peppers

Charter Oak is the name of a new pepper that will be released in 1943. It has many of the characteristics of an ideal pepper, such as early production, high yield, dark green color and thick flesh. The fruit is not as blocky as California Wonder but is acceptable. It received much praise at roadside markets in Connecticut in 1942.

Strawberries

The strawberry is a fruit that is high in vitamins and dessert value and, even in these times of emphasis on utilitarian crops, it cannot be neglected. Since its culture requires considerable labor from planting to harvest, it is especially important to obtain the largest yields with the least expenditure of time and materials.

As the result of a new system of inbreeding and crossing, five new varieties have been developed and named by the Station. During the past six years these have been compared in yield and time of ripening with the varieties commonly grown in this region and with new varieties from other sections. The results are summarized in a report and show that Shelton and Hebron rank next to Catskill in yield, and can be recommended as market berries for this section. The first is a main season variety; the second, a late. Another, Branford, is outstanding in attractiveness of fruit and does exceptionally well in some places.

Of the new varieties that have originated elsewhere, Pathfinder, Catskill and Dresden have been shown to be either more productive or more desirable in some respects than Howard Premier, the variety most commonly grown. Bristol and U. S. 1812 are not sufficiently productive for market but, because of their excellent table quality, are recommended along with Catskill, Dorsett and Fairfax for the home garden.

Russian Dandelion

With more than 90 per cent of the world supply of rubber now controlled by Japan, all possibilities of producing a natural supply on the Western Hemisphere are being explored. One of the most promising of temperate zone rubber plants is the Russian dandelion, *Taraxacum kok-saghyz*. Seed, obtained by the U. S. Department of Agriculture, was brought to this country by airplane and trial lots were sent to experiment stations in all

parts of the country where the common dandelion grows. A small plot at the Mount Carmel farm has produced a good stand of plants similar in habit of growth to the lawn weed. Yield of dry roots as well as the proportion and total amount of rubber produced, will be determined by the U. S. Department of Agriculture.

The dandelion can be grown on the same land and with the same machinery as sugar beets. It will produce rubber in one year. Since seed can be obtained from Russia and increased rapidly, and since large areas are available here for its cultivation, this plant seems to offer the best possibilities of all the temperate-zone plants that are being studied. Natural rubber has certain advantages that, so far, have not been duplicated in synthetic rubber.

Genetic Principles

Long-inbred strains of corn continue to show small degenerative changes such as reduced stature, light green color of chlorophyll, narrow leaves, aborted pollen and small tassels and ears, as well as lethal changes visible in germless and defective seeds, albino seedlings and barren stalks. These degenerative changes do not affect the hybrid offspring; that is, they are completely recessive. In one case there appeared in a long-inbred sweet corn line a reduced plant with shorter, more slender stalks and leaves and smaller ears. This gave a hybrid fully as good as, and in some cases larger than, crosses with the original inbred. In some combinations there is a noticeable change in the shape of the ear.

All of these facts have an important bearing on the theory of hybrid vigor and the maintenance of the inbreds now widely used in the production of hybrid sweet and field corn in all parts of the country.

Paired red and dark purple areas in the endosperm of light-colored maize seeds show outgrowths in less than one per cent of the color alterations. In 111 cases examined so far, no deviations from normal growth accompany the loss or exchange of both *Bt* and *Pr*. Since *Bt* is close to the centromere and *Pr* near the middle, changes that include both gene markers involve a loss or exchange of almost the entire right arm of the number 5 chromosome. If the increased growth were due to the uncovering of recessive growth regulators or the accumulation of dominant growth stimulators, all, or nearly all, of the color changes which include both markers would be altered in growth. Since none of them is, something other than normal gene action is involved. The progeny from these mosaic seeds show no unusual deviation from normal. Growth changes of this kind are lethal in embryos but survive when surrounded and nourished by normal tissue and furnish a basis for understanding the appearance of spontaneous neoplasms in other organisms.

Reciprocal translocations induced by X-ray treatment of pollen in a uniform inbred strain of corn have been compared with the original as stated in the 1941 report. A further study of these chromosomal rearrangements is being made to determine their effect upon growth and upon the expression of genetic determiners located near the points of breakage.

An attempt is being made to accumulate as many of these rearrangements as possible in one line and also to find a means of inducing additional arrangements in large numbers.

PLANT PATHOLOGY AND BOTANY

Fungicides

The department began to prepare for war several years ago when it embarked on a program of developing substitutes for copper fungicides and devising new techniques for testing and using both new and old materials. Pearl Harbor threw this work into sharp focus.

During this search it had been found that fungicides had best be tested at the dosages required for equal control, rather than with the older techniques of control for equal dosages. A paper on this was presented in December 1941 at the Science Meetings.

Dosage of Fungicides

Early in January 1942, it was realized that this new approach to fungicides could be turned immediately to war use. By showing how little fungicide is required without serious sacrifice of control, it is useful in helping to meet shortages of materials as they develop. Older techniques tested spray materials at single dosages. This gave no information on how much less control could be expected in case the dosage had to be reduced as a result of shortages.

From the data compiled on 16 plant maladies caused by fungi and insects, it is clear that halving the dosage reduces control by about 5 per cent. As an example, take 1,000 bunches of celery with 95 per cent the expected control of Septoria. Use of half the normal copper on all the 1,000 bunches would be expected to reduce the number of clean bunches from 950 to 900. If all the copper were used on half the acreage the number of clean bunches would be only 475.

Inspection of the data shows further that a cut in dosage to one-tenth reduces control by about one-third. In the case of the celery the number of clean bunches drops to 633 if the dose is spread over all the acreage, but it drops to 95 if all the dose is used on one-tenth the acreage. It might be thought that the use of only one-tenth the dosage was hardly worth spraying the celery for, and yet the grower may produce 538 clean bunches for his extra efforts.

The ideas developed by this approach reached print in Station Bulletin **455**. The scientific background for this bulletin appears in Bulletin **451**.

Efficiency of Application

As soon as reduced dosages appeared as a solution to spray material shortages, the point was raised immediately as to how the efficiency of application could be improved in order to salvage some of the loss produced. The new technique can be used to answer this too, although unfortunately

the war hit us before the possibilities in this direction had been fully realized.

Until recently work on efficiency had been measured in terms of control obtained. Efficiency could be elevated markedly without lifting the level of control much when the level of control was already high. What was needed was a measure of efficiency in terms of dose required, in order to learn how much the dosage could be reduced as the efficiency was improved.

In crop dusting it was realized that control of disease was somewhat better when the material was applied to dew-wet foliage than to dry foliage. The difference, however, was not sufficiently great to encourage growers to do strictly night dusting. During 1942 it was demonstrated with the new technique that dusting of dry foliage requires just twice as much yellow copper oxide as dusting of dew-damp foliage. If a vegetable grower was formerly dusting largely by day he could therefore keep his crops at the same level of health with half as much critically short copper, if he applied it at dawn on damp leaves.

The problems of efficiency of spraying as well as dusting need attention in terms of dosage required. Experimental designs were made up to test these factors on potatoes: nozzle size, number of nozzles per row, pressure and speed of movement of sprayer through the field. Unexpected difficulties arose in carrying out this research on potatoes but, nevertheless, the results were useful.

By August 10, 70 per cent control of tip burn was about the best obtained in the plots. If the sprayer were driven at three miles per hour and 100 gallons per acre were applied, 3.8 pounds of copper as bordeaux mixture were required per acre in each application to give this level of control. If, however, the driving speed were cut to one and one-half miles per hour so that 200 gallons were applied, the amount of copper required dropped to 1.3 pounds per acre. If the speed were lowered further to three-quarters of a mile per hour so that 400 gallons were applied per acre, the amount of copper required dropped to 0.36 pounds per acre.

On this basis copper can be saved easily by reducing the speed of the sprayer and applying more water. However, since time and labor are critical in Connecticut during the war, the results can be considered in still another light. If the copper applied were reduced to one-half by cutting the concentration in the tank, the control of tip burn fell only from 70 to 65 per cent. This difference would hardly be noticeable.

Substitute Fungicides

The search for substitute materials has continued. The most promising so far developed is tetra chlor quinone, now sold as Spergon. The consumption of this new material has reached the limit of manufacturing facilities. The War Production Board has mentioned it as a possibility for relieving the pressure on copper and mercury.

Two other recent materials, developed elsewhere, have been tested here. These are tetramethyl thiuram disulfide known as Thiosan, and ferric

dimethyl dithio carbamate, known as Fermate. Both have shown distinct promise as sprays for vegetables, fruits and roses. Other derivatives of these are being investigated.

During the past winter we have tested some 300 organic compounds already in production in industry. Most proved non-toxic to fungi or low in toxicity, but a few gave promise of further development.

One method of stretching copper supplies is to add the toxicity of an organic compound to the toxicity of the copper. We are now working on about a dozen of this type of chemical and some interesting materials are in process of testing.

Potato Spraying

It is important that Connecticut grow as much of its own food as possible in order to conserve transportation facilities. Potatoes grow well here but they must be sprayed to protect them against tip burn, flea beetle, late blight and other pests.

Bordeaux mixture has been the commonly recommended spray material but it is far from the ideal cure. It makes Connecticut potatoes produce more only because it is less injurious to them than are all their other troubles. In war-time it is especially important to lose the least possible potatoes through bordeaux injury. We have studied various factors in this problem and now we know how several of them perform. Potatoes should not be sprayed any earlier in the year than absolutely necessary because bordeaux is most injurious to the youngest tissues. The lime in the mixture should be reduced to at least half the bluestone because lime itself is quite toxic to potatoes. The number of applications should be kept at a minimum as the injury increases with the number of times the crop is sprayed. The concentration of the spray should be kept at a minimum since injury increases rapidly with concentration. Certainly not greater than 8-4-100 should be used. It might be well to use a concentration as low as 4-2-100 in the first application to young foliage.

Antidoting Fungous Toxins

Some startling new developments are being made in connection with the toxins secreted in the case of diseases like wilts of vegetables and Dutch elm disease. It now seems likely that such diseases may be successfully combated by drugs introduced into the sap streams of plants.

Chemotherapy for Peach X Disease

For many years we have thought that the strange troubles of plants called virus diseases could not be combated chemically as other diseases often are, because the viruses are located deep in the tissues. In the case of the X disease of peach, up to now all we could do was to cut down and incinerate the trees.

Recent work here shows that possibilities of chemical control do exist. This new research indicates that chemicals can be introduced into the tissues where they will seek out and destroy the virus. Hope now arises that eventually a means will be found to cure peach trees sick with X disease.

SOILS

TODAY war requires explosives in astronomical quantities. The problem of supply is a serious one and has been in all the nation's wars. Explosives are built around nitrogen. But plants also require nitrogen and our modern eastern agriculture, like war, is geared to nitrogen, in this case in fertilizers. Since the last war nitrogen has been relatively cheap and has been used liberally. Again we are at war and, until the problems of ample production are solved, the available supply must be made to stretch as far as possible, without reducing yields. As a guide to safe practice we turn to the results of the many experiments here and elsewhere. Crops vary widely in their response to increments of fertilizer nitrogen. All of our important Connecticut crops have been studied carefully over the years and now these data are of vital importance.

Soil Maintenance for Vegetable and Potato Farms

On dairy farms soil organic matter can be maintained without too great difficulty. The same is true of tobacco, even under continuous cropping. But vegetables, grown today without manure, offer a serious problem. To solve this, a new series of plots was begun at Windsor in 1940. The objective is threefold: to determine (1) the effects of green manures and stable manure on soil organic matter, for different rotations and crops; (2) the response of these several crops, in the different rotations, to different levels of nitrogen fertilization and (3) the effect of certain crops on subsequent crops.

Potato Rotation Experiments

Experiments on rotating potatoes with tobacco, corn, turf (clover) and continuous potatoes have been carried on for six years. In this period tobacco has shown satisfactory yields as well as quality. Continuous potatoes, in comparison with the other rotation systems, produced about 2.5 per cent less yield per acre for the same period.

Moreover, if the total return from continuous potatoes be taken as 100, potatoes after corn gives a value of 100.6, potatoes after turf (clover) 100.9 and potatoes after tobacco 106.3. Corresponding values for U. S. No. 1 grade are 100, 103.25, 103.40 and 107.60.

Continuous potatoes show a tendency toward gradually diminishing yields—10.6 per cent less per acre in 1942 than in the first year of the trial, while potatoes after tobacco now (1942) yields 15.8 per cent more per acre than at the beginning of the test. Corn and turf (clover) seem to maintain the original potato-yielding capacity of the experimental field.

Poultry Manure Experiment

Poultry manure was collected from five sources and subjected to complete chemical analysis. Comparative tests of each manure along with a mineral fertilizer were carried on in the greenhouse with a soil deficient in nitrogen supply. A tobacco crop, followed by sudan grass for residual effects, was grown. The resulting yields indicated that poultry manure could be substituted for mineral fertilizer as a source of plant nutrients.

Humus and Green Manures

Comparisons between peat (two types), sheep manure, dried cow manure and tobacco stems as humus amendments on a sandy soil at Windsor have shown general benefit from all the organic materials. The yields for three crops (cabbage, corn and carrots) averaged 27 per cent greater in comparison with fertilizer alone.

In the green manure trials at Windsor, millet provided approximately 5,300 pounds of organic matter, while soybeans produced only 2,350 pounds per acre. Top-dressing the millet with nitrogen (40 pounds per acre) produced 31.5 per cent increase in dry matter. There was a 49.7 per cent increase of nitrogen in the nitrogen top-dressed millet.

Soil Testing

With fertilizer short and the need for food increased, efficient use of plant food materials becomes a first consideration. The soil tests perfected here have become a war tool of first importance. This year some 6,500 soil samples were examined.

Neutralization of Acid-Forming Nitrogenous Fertilizers

The rate of nitrification of sulfate of ammonia, urea and cottonseed meal was accelerated by neutralizing treatments. Ammonia nitrogen was leached from the sandy soils receiving sulfate of ammonia and urea when heavy rains occurred early in the season. The ammonia nitrogen leachings were smaller when these materials were neutralized.

Lime applied in quantities equivalent to the acidity of the fertilizers serves to maintain the net base status of the soil at a fairly constant level except when applied in connection with a less fully available nitrogen material, such as cottonseed meal. Liming also produces a change in the distribution of the various exchangeable bases, making the soil more productive for alfalfa even at pH levels generally considered very unfavorable for this crop.

Interrelations of Nitrogenous Fertilizers

A ten-year study in lysimeter tanks of 15 nitrogenous fertilizers has been completed and the findings published as Station Bulletin **458**. Each material was applied annually at the rate of 200 pounds of nitrogen per acre, together with the equivalent of 100 pounds of phosphoric acid, 200 pounds of potash and 50 pounds of magnesium oxide. Each tank was set to one tobacco plant which, when mature, was dried, weighed and analyzed. Composites of leachate were made at the conclusion of each leaching rain and were analyzed for various soluble constituents.

Among other things it was found that the readily available nitrate fertilizers supply more nitrogen to the crop and are more completely removed from the soil by crop and leaching than any of the other materials used. When sulfate of ammonia and ammophos were used there was good evidence that a considerable proportion of the nitrogen in a crop was taken up as ammonia ions.

In the case of cottonseed meal, castor pomace, fish meal, and other natural organic materials, much of the nitrogen was not recovered in either the crop or the drainage water, and significant gains in soil nitrogen were in evidence at the end of the experiment. It is estimated that of the 200 pounds of nitrogen added in organic materials of availability similar to cottonseed meal, approximately 125 pounds become available during the growing season of the tobacco crop. The nitrogen in manure was much less available than that in any of the fertilizer materials.

The soil that received no nitrogen showed a nitrogen loss that could be accounted for in crop removal and leaching. The soil organic matter was depleted at a rate of approximately 1,000 pounds annually. Organic matter losses were equally great where nitrate fertilizers had been used but were definitely retarded with some of the organic sources of nitrogen. Castor pomace and manure produced gains of considerable magnitude in soil organic matter.

Spent Acid Superphosphate and Plastic Waste as Fertilizers

Large quantities of sulfuric acid are used in the production of high octane gasoline, and much of the spent acid is available for use in the manufacture of superphosphate. This Station is cooperating with the Federal Government in determining the suitability of spent acid superphosphate as a fertilizer. In field experiments conducted during the past summer on alfalfa and sweet corn for seed, this material was just as effective as superphosphate made with fresh acid.

Plastic waste contains as much as 20 per cent nitrogen and several manufacturers have been interested in knowing whether or not this material is of value as a fertilizer. Preliminary experiments with tobacco and lawn grass indicate that plastic waste can be so used but that care must be taken not to apply it at too high a rate. These materials vary greatly in composition and some are very toxic in heavy applications. It is believed that this material would be most effective as one ingredient in a mixture which would include some other soluble nitrogen fertilizer such as sulfate of ammonia or one of the nitrate salts.

Forest Soils

Further Data on the Effect of Slash on Tree Growth

Measurements of the 1942 leader growth of white pine saplings indicate that the increased rate of growth due to the presence of slash observed last year has continued through 1942. Plantings of 2-1 white pine and Norway spruce were made in April 1942 in heavy slash, in areas without slash and where the slash had been burned. Counts and measurements at the end of the first growing season show a slightly higher survival in the slash and in the burned areas, but no significant difference in height of the plants. It is expected that growth differences will begin to show up next year.

Effect of Litter Removal and Liming in a Red Pine Plantation

Analyses pertaining to soil changes resulting from 10 years of raking, burning and liming have been completed. Briefly, these have shown that

on sandy soils, such as the one on which this plantation is located, yearly removal of the litter either by raking or burning resulted in poorer moisture conditions in the top soil. Burning was somewhat less deleterious than raking because of the favorable effect of the ash on the soil. The use of lime was favorable to nitrification, to base saturation, exchangeable calcium and available phosphorus. Although the effect of these treatments on tree growth was slight at the end of the first five-year period it is believed that subsequent measurements will reveal important differences.

Field Plantings of Forest Stock

Further counts and measurements were made of Norway and white spruce trees which had been set out in the field in the spring of 1941. Stock that had been previously fertilized in the nursery with 1,200 pounds of 12-4-4, 4-12-4 or 4-4-12, but had not received fertilizer in the field showed no improvement in survival or growth over the untreated trees.

Plants not especially fertilized in the nursery but treated at time of planting in the field with 6-10-4 fertilizer showed a somewhat poorer survival but no consistent improvement in growth, as compared with the untreated trees. Neither vitamin B_1 nor starter solution had any significant effect upon either survival or growth.

Soil Studies of Forestry Plots

In the fall of 1941 thorough samplings were made of some 28 state forest plots in which growth measurements are taken at intervals by the State Department of Forestry. Analyses of the soil are now in progress and when completed will be correlated with growth data.

TOBACCO SUBSTATION AT WINDSOR

A special report of the Tobacco Substation is published each winter but a few items of special interest are recorded here. Several new emergency problems were attacked, most of them related to the changes in the fertilizer available.

Soil Experiments

Poultry Manure

Poultry raising has increased greatly in the tobacco-growing sections of the State in recent years. With the supply of manure more abundant, many growers have asked whether it could be used for fertilizing tobacco and what effect it would have on yield and quality of the leaf. Since there seems to be a dearth of experimental evidence to answer these questions, two field plots were fertilized in 1942 with 10 tons of fresh chicken manure per acre with the addition of 300 pounds of cottonhull ash to bring the potash content up to the standard 200 pounds. As a control, two other plots received 2,500 pounds of our regular 8-4-8 mixture plus 700 pounds of bone meal, to equalize the phosphorus. As far as appearance in the field is concerned, all plots seemed to thrive equally.

Residual Effect of Stable Manure

Two strips across a two-acre field had received heavy annual applications of stable manure for 10 years previous to setting the field in tobacco in

1940. The first tobacco crop showed an increase of 25 per cent in yield and 33 per cent in grading due to the residual effect of the previous manure application. The second crop gave an increase of 7 per cent in yield but no significant increase in grading due to residual influence of manure. Results of the third year have not yet been tabulated but more luxuriant growth on these strips was plainly evident throughout the growing season, showing that the effect has not ceased even after three years. All the fields received regular dosages of commercial fertilizer during these three years.

Fertilizer Placement

Broadcasting is the universal method of applying fertilizer for tobacco in the Connecticut Valley. However, on a number of other crops, placing the fertilizer in bands on each side of the row has resulted in better yields or economy in fertilizer. Two years ago an experiment was started to test this on tobacco. The results to date are not conclusive, but so far banding has given a significant increase over broadcasting when the same amount of fertilizer was used. When the amount was reduced, the yield was depressed. The reasons for this are not clear and further work will be necessary.

Relative Efficiency of Nitrogen from Cottonseed Meal, Castor Pomace and Soybean Meal

Field tests for two years on triplicate plots show that 160 pounds of nitrogen in castor pomace or 170 pounds of nitrogen in soybean oil meal are as efficient as 200 pounds of nitrogen in cottonseed meal in furnishing the nitrogen for the fertilizer formula. Differences in efficiency of the three materials are due to differences in speed of decomposition and nitrification in the soil. Soil tests through the short growing season for tobacco show that the nitrate level is approximately the same for the three dosages mentioned. Crop response is proportional to the soil nitrate level.

Tobacco Diseases

"Black" Shade Tobacco

It has been shown in previous reports that these objectionable black leaves come from excessively acid fields with soil deficient in calcium and/or phosphorus. Also black leaves contain more manganese and iron than light leaves, absorbed more readily from soils with the deficiencies mentioned. The purpose of the field tests of 1941 and 1942 was to see to what extent "blackness" could be eliminated by treating the soil with lime or phosphate or both. Plots in triplicate were treated with different increments of triple superphosphate and lime.

The lowest proportion of black leaf and the highest crop value was obtained on the plots which received the highest application of phosphorus (192 pounds P_2O_5 per acre) annually, with or without lime. Lime alone was much less effective than phosphorus and in most cases was of no value. Chemical analyses of tobacco from the best and poorest plots showed that, on any particular plot, the darker the leaf color, the greater

the percentage of iron and manganese in the leaves at any level on the stalk. Leaves containing more than 0.16 per cent iron and 0.03 per cent manganese were black and of very inferior quality.

In view of the results of these studies it is suggested that this trouble may be eliminated by judicious liming and heavy applications of available phosphorus to fields known to produce black tobacco.

Pole Rot

The rotting of leaves in the shed during the curing process (pole sweat, pole rot) may be caused by any one of a number of fungi and exhibits different symptoms depending on the fungi involved and the environmental conditions. The term "pole rot" thus refers to a group of diseases rather than to one disease. Several of these have been studied and described in previous reports.

The prevalent type in 1942 was a vein and web rot caused by Sclerotinia and Botrytis. In Shade and Primed Havana Seed tobacco the disease starts from infected leaves brought in from the field and the rot spreads rapidly through the crowded leaves in contact on the same lath while the leaves are still green ("green web-rot"). Infected leaves are a complete loss. In stalk-cut tobacco, however, the rot starts from the infected stalks and either runs out through the midribs causing them to break down ("vein rot") and separate from the web, or it may pass directly to the blade of leaves which come to be in direct contact with the infected stalk or other infected leaves during the wilting process. Affected leaves are worthless for cigar manufacture and are therefore thrown out during the sorting.

Pole rot is dependent on damp weather during the curing season. Since this type works on the leaves while they are still green, fire curing must be started earlier than for the types that attack the yellow leaves. Heavy firing and rapid cure make atmospheric conditions in the shed unfavorable for Sclerotinia pole rot.

Downy Mildew

Among the rank and file of tobacco growers, mildew is regarded as our most important disease and the one to be most guarded against. But from the standpoint of financial loss it is probably secondary to pole rot.

Most important advance of the year in controlling mildew was the discovery that it could be prevented by keeping the plants sprayed with "Fermate" (ferric di-methyl di-thiocarbamate) at the rate of 1½ to 2 pounds per 100 gallons of water applied twice a week. Results were satisfactory both in experimental beds at the Station and in the seed beds of cooperating growers. Many other chemicals tried were either not effective or less effective than Fermate.

More effective methods of controlling mildew by fumigation with paradichlorobenzene were also determined. When this crystalline material is distributed on an 18-inch wide strip of cheese cloth running lengthwise through the middle of the bed or on removable cloth frames spaced so

as to cover about a third of the bed area, quite satisfactory control was obtained even under low temperature conditions where the usual wire basket method failed to give good control.

Sclerotinia and Botrytis

The two fungi *Sclerotinia sclerotiorum* and *Botrytis cinerea* under certain conditions attack the tobacco plant in different stages of its development causing several diseases with different names, depending on the stage at which the attack occurs. Since some of these were very prevalent and destructive in 1942 and moreover have not previously been reported from this region, an investigation was begun this year.

The most prevalent phases this year were leaf rot and stalk canker in the field and stalk rot and pole rot in the curing shed. Both fungi were found to be highly pathogenic, yet the spores of neither are capable of directly causing infection of healthy green leaves and stalks. The usual avenue of attack is through the flowers which are readily infected by spores. When the faded corollas, full of fungous mycelium, fall onto the leaves, the fungus by mass action passes into and rots the normal green leaves. From the leaves, the parasite runs down into the stalk causing stalk cankers and ultimate collapse of all parts above the cankers. Because of the role of flowers in the fungus life history, the field losses are almost entirely in Shade and Primed Havana types. When infected leaves are hung in the curing sheds, the disease passes rapidly into the other leaves causing a serious type of pole rot. Financially, the shed damage is more serious than the field losses. Stalk rot in the shed was common in Havana Seed and Broadleaf types. Infection seems to be through wound tissues originating from topping, suckering and harvesting operations. From the stalks, the rot passes into the mid-veins of the leaves causing a type of vein rot.

Sclerotinia also occasionally causes a bed rot of seedlings but this was not found this year and is not the usual type of bed rot. Soil sterilization is an effective preventive against this type.

No practical remedy for leaf rot and canker in the field has been found. The shed troubles may be largely prevented by proper and early firing with charcoal.

Sterilizing Tobacco Beds with Chlorpicrin (Tear Gas)

Chlorpicrin (tear gas) was used in comparison to steam for sterilization of tobacco beds in the fall of 1941. Observations on the appearance of weeds the following spring showed that steam sterilization reduced the number of weeds to 2.8 per square foot; chlorpicrin reduced the numbers to 6.1 while the control blocks showed 13.4 weeds per square foot. Chlorpicrin had reduced the number of weeds by 55 per cent, although some individual blocks of the treated bed showed a weed kill of about 70 per cent. Steam reduced the weed stand by 80 per cent.

Experiments with chlorpicrin, done on a larger scale in cooperation with commercial growers, showed good weed control with this material.

BIOMETRY

Two years ago Dr. C. I. Bliss came to the Station as Consulting Biometrician, on a part-time basis. The importance of some such arrangement had long been recognized. In recent years new statistical methods have been devised, for use in designing experiments, both in the laboratory and the field, and for evaluating results. These are new tools, as important as are new laboratory methods or machines. However, very few scientists can be competent biometricians, this being a highly specialized field.

All departments of the Station have voluntarily sought Dr. Bliss' aid in planning experiments and in the analysis of data. The results have been highly satisfactory and the work of the Station definitely improved. By the proper use of modern biometrical techniques, smaller differences have been accurately determined or the significance and meaning of the results made clearer. Much time has been saved and better results obtained.

Biometrical Research

In addition to his direct service to the staff, Dr. Bliss has carried out several researches in methods, the material for some of which originated in the Station. The chick assay for vitamin D has been the subject of a number of experiments, including a cooperative study with the Storrs Experiment Station to test the possibility of using creeper chicks for improving this assay.

A major project was a critical review on biological assay prepared by invitation for the Annual Review of Physiology. The pharmacological aspects of bioassay were handled by Professor McKeen Cattell of Cornell University, and the general principles and statistics here at the Station. Three tables have been computed to show the precision attained in assays selected from among the more than 270 references of this paper.

Criticism of Scientific Papers

At the request of the editors of various scientific journals or of members of the Station staff who have been asked to referee papers in quantitative biology, manuscripts have been reviewed with especial reference to their statistical aspects for the Journal of Agronomy, the Journal of Economic Entomology, the Journal of Biochemistry, the Journal of Pharmacology and Experimental Therapeutics, the Journal of the American Statistical Association and Soil Science.

THE LIBRARY

No part of a research institution is more important than its library. It is the record of research through the generations. In these days, when every bit of scientific information must be drafted and put to its best use, the library assumes a vital role. Fortunately the Station is well equipped in this respect, its files running in some cases to 1850, when Professor Johnson, our founder, began to collect journals and books.

During the year ending October 31, 1942, the Station Library had the following number of additions:

U. S. Department of Agriculture publications	754
State Agricultural Experiment Station publications	1,010
Scientific and agricultural domestic and foreign journals	1,651
Single books purchased	68
Total	3,483

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

The total number of cloth and paper bound volumes on hand is now 27,130. Most of the U. S. Department of Agriculture and State Experiment Station publications, as well as scientific journals, are received in pamphlet form and are not included in the volume count until bound.

LIST OF PROJECTS

active in 1942 - 43

Analytical Chemistry

1. Inspection of fertilizers.
2. Inspection of feeding stuffs. (Including biological assays of vitamin D supplements for poultry feeds.)
3. Inspection of food 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 on analytical methods.
9. Examination of biological specimens in connection with suspected poisoning of livestock.

(Nos. 2, 3, 4 and 5 are in coöperation with the Dairy and Food Commissioner.)

Biochemistry

1. Cell chemistry.
   a. A detailed examination of the chemical composition of plant tissue 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.
   b. 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. Studies on the control of the Oriental fruit moth, including parasites. (In coöperation with the U. S. Dept. of Agr.)
28. Investigations on oil sprays.
30. Biology and control of insects that attack tobacco. (See also Tobacco Substation, No. 20.)
31. Studies on the biology and control of the European pine shoot moth.
37. Substitutes for lead arsenate in orchard sprays in apple maggot control.
38. The relation of rate of growth and pruning methods to the recovery of white pine to weevil injury.
40. Studies on the control of the European corn borer. (In coöperation with the U. S. Dept. Agr.)
43. The spruce gall aphid.
44. Bark beetles of the elm.
45. Investigation of parasites of the Japanese beetle.
48. Studies of predators affecting the European red mite.
49. Adhesives for standard spray mixtures.
51. Soil and grassland insect investigations.
52. Study of wireworm injury to potatoes.
53. Rodent control. (In coöperation with the U. S. Fish and Wildlife Service.)
55. The biology and control of *Calomycterus setarius* Roelofs.
56. Studies of dusts. (In coöperation 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.

Control and Service

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

Forestry

1. Experimental plantations on a sandy tract at Rainbow.
   a. Comparison of many species of conifers and hardwoods, in pure stands and in combinations, as to growth and habits.
   b. Methods of management for those species that have survived.
   c. The properties of the wood of several of the important species. (In coöperation with the Yale Forestry School.)
6. Studies of forest plantations throughout the State.
   a. Growth and yield of several species in relation to site. (The present studies are on red pine, in coöperation with the State Forester and the Yale Forestry School.)
   b. Properties of red pine wood grown in plantations. (In coöperation with the Yale Forestry School.)
12. The utilization of native woods. (In coöperation with the State Forester, State Highway Dept., Conn. Forest & Park Assoc., Yale Forestry School, and U. S. Forest Service.)
   a. Preservative treatments of posts and other materials.
   c. The use of hogged wood as a fuel.
   d. Problems involved in the combustion of wood. (In coöperation with the Dept. of Mech. Eng., Yale University.)

Control and Service

5. Distribution of forest planting stock.
7. Control of white pine blister rust. (In coöperation with the U. S. Dept. Agr.)

Genetics (Plant Breeding)

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

Plant Pathology and Botany

5. Plant disease survey of Connecticut.
20. Diseases of shade trees.
27. The Dutch elm disease and related diseases.
28. Studies on the identification of apple varieties by seed characters. (Inactive)
30. Diseases of vegetable crops and their control.
   a. Downy mildew of muskmelons and cucumbers.
   b. Defoliation and related diseases of tomatoes.
   d. Wilt diseases of tomatoes and eggplant.
31. Investigation of the X-disease of peach.
33. Diseases of ornamental plants.
   Rose diseases—powdery mildew, black spot.
34. Fungicides, new and old.
35. Apple spraying.
36. Antidoting phytotoxins and viruses by chemotherapy.
37. Root rot diseases of plants.

Control and Service

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

Soils

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

Tobacco Substation

1. Fertilizer experiments.
   - ac. Starter solutions and hormones.
   - bb. The relative efficiency of nitrogen from castor pomace, soybean oil meal and cottonseed meal.
   - e. Comparison of various single sources of nitrogen.
   - fa. Comparison of sources of phosphorus.
   - qa. Fertilizer placement tests.

2f. Poultry manure as a fertilizer for tobacco.
4. Tobacco nutrition studies.
   - d. Symptoms of food element deficiency.
   - h. Ammonification and nitrification of fertilizer materials. (Inactive)
   - j. Absorption of magnesium from different carriers.

7aa. Improvement of Shade tobacco by selection and breeding. (In coöperation with the Conn. Leaf Dealers Assoc.)
9a. Brown root rot control in field plots.
13. Preservative treatment of shade tent poles. (See also Forestry, No. 12.)
15a. Topping experiments.
17b. The study of the cause of black Shade tobacco.
19. Investigation of various tobacco diseases.
   - c. Pole rot.
   - e. Breeding for mosaic resistant Broadleaf.
   - f. Control of downy mildew.
   - h. Breeding for resistance to downy mildew.
   - i. Sclerotinia and Botrytis diseases of tobacco.

20. The biology and control of insects that attack tobacco. (See also Entomology No. 30.)
22. Irrigation of tobacco.
25. Spacing of Havana Seed Tobacco. (Inactive)
26. Chlopicrin for sterilization of tobacco bed soil.
30. Chemical investigations. (In coöperation with the American Tobacco Co.)
31. Breeding for low nicotine content of leaf.

PUBLICATIONS

July 1941 to July 1942

BULLETINS OF THE STATION

CONNECTICUT STATE ENTOMOLOGIST. FORTIETH REPORT, 1940. R. B. Friend. No. **445.**

ANNUAL REPORT FOR THE YEAR ENDING OCTOBER 31, 1940. No. **446.**

REPORT ON FOOD PRODUCTS AND DRUGS FOR 1940. E. M. Bailey. No. **447.**

A PORTABLE CHARCOAL KILN USING THE CHIMNEY PRINCIPLE. A. Richard Olson and Henry W. Hicock. No. **448.**

FOREST LYSIMETER STUDIES UNDER HARDWOODS. Herbert A. Lunt. No. **449.**

CHEMICAL SOIL DIAGNOSIS BY THE UNIVERSAL SOIL TESTING SYSTEM. M. F. Morgan. No. **450.**

ROLE OF THE DOSAGE-RESPONSE CURVE IN THE EVALUATION OF FUNGICIDES. A. E. Dimond, J. G. Horsfall, J. W. Heuberger and E. M. Stoddard. No. **451.**

ANNUAL REPORT FOR THE YEAR ENDING OCTOBER 31, 1941. No. **452.**

COMMERCIAL FERTILIZERS. REPORT FOR 1941. E. M. Bailey. No. **453.**

DISTRIBUTION OF ROOTS OF CERTAIN TREE SPECIES IN TWO CONNECTICUT SOILS. George I. Garin. No. **454.**

MEETING THE SPRAY MATERIAL SHORTAGE. Neely Turner and James G. Horsfall. No. **455.**

CAUSES, EFFECTS AND CONTROL OF DEFOLIATION ON TOMATOES. James G. Horsfall and John W. Heuberger. No. **456.**

TOBACCO SUBSTATION AT WINDSOR. REPORT FOR 1941. P. J. Anderson and T. R. Swanback. No. **457.**

SOIL AND CROP INTERRELATIONS OF VARIOUS NITROGENOUS FERTILIZERS. WINDSOR LYSIMETER SERIES B. M. F. Morgan and H. G. M. Jacobson. No. **458.**

CIRCULARS OF THE STATION

CONTROL OF THE EUROPEAN CORN BORER BY SPRAYS AND DUSTS. Neely Turner. No. **147.**

SWEET CORN HYBRIDS. LEXINGTON, LINCOLN AND LEE. W. R. Singleton and D. F. Jones. No. **148.**

HERBS AND THEIR CULTURE. Ruth M. Hendrickson and Frances M. Johnson. No. **149.**

THE HOME VEGETABLE GARDEN. No. **150.**

LAWS AND REGULATIONS CONCERNING THE INSPECTION OF NURSERIES IN CONNECTICUT AND TRANSPORTATION OF NURSERY STOCK. R. B. Friend and M. P. Zappe. No. **151.**

YANKEE HYBRID SUMMER SQUASH. AN EARLY, PRODUCTIVE FIRST GENERATION CROSS. Lawrence C. Curtis. No. **152.**

REPORT ON COMMERCIAL INSECTICIDES AND FUNGICIDES. 1942. H. J. Fisher. No. **153.**

JOURNAL PAPERS

BEARD, R. L. A note on *Lagochirus araneiformis* L. (Coleop.: Cerambycidae). Ent. News, **53**: 60-62. 1942.

————. On the formation of the trachael funnel in *Anasa tristis* DeG. induced by the parasite *Trichopoda pennipes* Fabr. Ann. Ent. Soc. Amer., **35**: 68-72. 1942.

BEARD, R. L., and P. P. WALLACE. Prothetely in *Scolytus multistriatus* Marsham (Coleop.: Scolytidae). Ent. News, **52**: 42-244. 1941.

CHEN, K. K., C. I. BLISS, and E. B. ROBBINS. The digitalis-like principles of calotropis compared with other cardiac substances. Jour. Pharmacol. and Expt. Ther., **74**: 223-234. 1942.

CLARK, F. J. Preliminary investigation in *Zea mays* of the germination capacity of pollen with aberrant nuclei. (Abs.) Genetics, **27**: 137. 1942.

DIMOND, A. E. The reversal effect: Why fungicides change in rank in repeated field tests. (Abs.) Phytopath. **32**: 3. 1942.

FRIEND, R. B. The black carpenter ant. Pests and Their Control, **10**: 12-14. 1942.

GARMAN, PHILIP. Fruit insects abundant. Pomol. Pointers for Conn. Fruit Growers. June, 1942.

————. Parasites for control of fruit insects. Pomol. Pointers for Conn. Fruit Growers. March, 1942.

————. Report on oriental fruit moth parasite work for 1941. Conn. Pomol. Soc. Proc., **44**: 111. 1942.

————. Report on orchard insects. Pomol. Pointers for Conn. Fruit Growers. July, 1942.

————. Safer sprays for bees—from the standpoint of the orchardist. Conn. Honey Bee, **13**: 2-4. 1941.

————. Timely observations on the outlook for insect outbreaks. Pomol. Pointers for Conn. Fruit Growers. May, 1942.

GARMAN, PHILIP, H. W. DAVIDSON, and R. B. OWEN. Report of the Committee on Injurious Insects. Conn. Pomol. Soc. Proc., **44**: 101-103. 1942.

GARMAN, PHILIP, and E. M. STODDARD. Outlook for fruit pests in 1942. The Rural New Yorker, **101**: 256-257. 1942.

HEUBERGER, J. W. Effect of copper content, completeness of admixture of copper and diluent, and nature of diluent on field performance of copper dusts. (Abs.) Phytopath., **32**: 8. 1942.

————. Improved control of *Alternaria solani* (Early blight) on tomatoes by controlling flea beetles. (Abs.) Phytopath., **32**: 8. 1942.

HEUBERGER, J. W., and A. E. DIMOND. Relation of flea beetle control to control of *Alternaria solani* on tomatoes. Plant Disease Reporter, **25**: 415-418. 1941.

HEUBERGER, J. W., and J. G. HORSFALL. Reduction in fungicidal value of copper compounds by organic materials. Phytopath., **32**: 370-378. 1942.

HEUBERGER, J. W., and NEELY TURNER. A laboratory apparatus for studying settling rate and fractionation of dusts. Phytopath., **32**: 166-171. 1942.

HORSFALL, J. G., and A. E. DIMOND. Comparing fungicides at dosages for equal control. (Abs.) Phytopath., **32**: 10. 1942.

HORSFALL, J G., and J. W. HEUBERGER. Measuring magnitude of the defoliation disease of tomatoes. Phytopath., **32**: 226-232. 1942.

HORSFALL, J. G., and G. A. ZENTMYER. Antidoting the toxins of plant diseases. (Abs.) Phytopath., **32**: 22-23. 1942.

HORSFALL, J. G., and G. A. ZENTMYER. Chemotherapy for vascular diseases of trees. Natl. Shade Tree Conf. Proc. 1941. pp. 7-15.

JOHNSON, F. M. Mechanical injury to onion seeds. News Letter Assoc. Official Seed Analysts. **16** (2): 8. 1942.

JOHNSON, J. P. The control of Japanese beetle grubs in turf. Newsletter, Greenskeepers Club of New Eng., **14**: 6-7. 1942.

JONES, D. F. Chromosome degeneration in relation to growth and hybrid vigor. Natl. Acad. Sci. Proc., **28**: 38-44. 1942.

————. Natural and induced changes in chromosome structure in maize endosperm. Natl. Acad. Sci. Proc., **27**: 431-435. 1941.

LUNT, H. A. A pot culture experiment with undisturbed forest soil. (Abs.) Soil Sci. Soc. Amer. Proc., **6**: 403. 1941.

PUCHER, G. W., and H. B. VICKERY. Succinic acid as a metabolite in plant tissues. Plant Physiol., **16**: 771-783. 1941.

ROBERTS, L. M. The effects of translocation on growth in *Zea mays*. (Abs.) Genetics, **27**: 166. 1942.

SINGLETON, W. R. On a system of filing reprints. (Abs.) Science, **95**: 274-275. 1942.

SMITH, R. L. Historical sketch of Connecticut State Laboratory. History Assn. Official Seed Analysts. pp. 15-16. Nov., 1941.

SPURR, S. H., and R. B. FRIEND. Compression wood in weeviled northern white pine. Jour. For., **39**: 1005-1006. 1941.

STODDARD, E. M. Inactivating in vivo the virus of the X-disease of peach by chemotherapy. (Abs.) Phytopath., **32**: 17. 1942.

————. Report on fruit diseases for 1941. Conn. Pomol. Soc. Proc., **44**: 103. 1942.

————. The X-disease of peach. Amer. Fruit Grower. Aug., 1941.

STODDARD, E. M., and A. E. DIMOND. Control of apple scab with some new fungicides. Conn. Pomol. Soc. Proc., **43**: 10-17. 1941.

TURNER, NEELY. Insecticides. Amer. Professional Pharmacist, **7**: 366-368, 582. 1941.

VICKERY, H. B. End-products of nitrogen metabolism in plants. Biol. Symposia, **5**: 3-19. 1941.

————. Liebig and proteins. Jour. Chem. Ed., **19**: 73-79. 1942.

————. Liebig and the chemistry of proteins. Liebig and After Liebig: Amer. Assn. Adv. Sci. Pub. No. **16**: 19-29. Washington. 1942.

————. The preparation of histidine by means of 3, 4-dichlorobenzenesulfonic acid. Jour. Biol. Chem., **143**: 77-87. 1942.

VICKERY, H. B., E. L. SMITH, R. B. HUBBELL, and L. S. NOLAN. Cucurbit seed globulins. I. Amino acid composition and preliminary tests of nutritive value. Jour. Biol. Chem., **140**: 613-624. 1941.

WALLACE, P., and R. L. BEARD. Larval characteristics of certain elm bark infesting Coleoptera. Can. Ent., **74**: 86-87. 1942.

ZENTMYER, G. A. Cytospora canker of Italian cypress. Phytopath., **31**: 896-906. 1941.

————. Toxin formation and chemotherapy in relation to Dutch elm disease. Phytopath., **32**: 22. 1942.

————. Toxin formation by *Ceratostomella ulmi*. Science, **95**: 512-513. 1942.

All of which is respectfully submitted.

WILLIAM L. SLATE,
Director.

REPORT OF THE TREASURER

W. L. SLATE, Treasurer, in account with the Connecticut Agricultural Experiment Station.

July 1, 1941 to June 30, 1942

INCOME

STATE APPROPRIATIONS:	
Regular Funds	$255,473.10
Special:	
Construction and Plant Improvements	10,708.90
Feed Fees	17,300.00
Fertilizer Fees	13,445.00
Miscellaneous	183.44
Trust Funds and Grants	22,937.28
FEDERAL APPROPRIATIONS:	
Adams	7,500.00
Hatch	7,500.00
Bankhead-Jones	11,253.66
Purnell	30,000.00
	$376,301.38
Unexpended Balance	41,995.25
Net Income	$334,306.13

July 1, 1941 to June 30, 1942

EXPENDITURES

	Personal Services	Contractual Services	Supplies and Materials	Capital Outlay	Totals
STATE APPROPRIATION:					
Station General Fund	$ 68,679.39	$ 6,163.79	$ 9,116.15	$ 6,336.19	$ 90,295.52
Bee Diseases (Inspection)	1,746.00	1,100.90	10.55	.....	2,857.45
Food and Drug Analyses	8,710.40	181.10	710.45	142.59	9,744.54
Gypsy Moth Suppression	36,026.50	1,002.74	2,228.73	1,605.35	40,863.32
Insect Pest Control and Research	49,185.61	2,015.46	2,182.60	8,448.67	61,832.34
Tobacco Substation	15,971.08	686.76	2,010.70	300.96	18,969.50
White Pine Blister Rust Control	3,473.59	644.45	162.97	14.70	4,295.71
Construction and Plant Improvements	.....	.....	.....	8,070.48	8,070.48
FEDERAL FUNDS	51,957.14	418.03	2,488.71	1,389.78	56,253.66
FEED INSPECTION	14,849.80	453.80	714.40	509.90	16,527.90
FERTILIZER INSPECTION	10,545.00	1,113.12	539.02	433.55	12,630.69
TRUST FUNDS AND GRANTS	8,947.55	329.64	1,704.29	983.54	11,965.02
Net Expenditures	$270,092.06	$ 14,109.79	$ 21,868.57	$ 28,235.71	$334,306.13