Bulletin 357 January, 1934

REPORT OF THE DIRECTOR

For the Year Ending

October 31, 1933

Connecticut
Agricultural Experiment Station
New Haven

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Printing by Quinnipiack Press, Inc., New Haven, Conn.

REPORT OF THE DIRECTOR

For the Year Ending October 31, 1933

To the Board of Control of the Connecticut Agricultural Station:

The Station year just ended has brought us many perplexities but also it has been a period of unusual opportunity. Farming at best is a constant struggle. Each season seems to bring new pests, new competition from other regions. In periods of low prices, such as are now prevailing, the difficulties are exaggerated. However, in spite of great discouragements, our farmers in general have carried on in much the usual manner. Personal expenditures have been curtailed as income has shrunk. It has been most interesting to observe a change in the thinking of country people, a greater interest in life and living than was evident during the period of prosperity. Perhaps this is due to a number of influences. In any case, it suggests a new opportunity for those who are charged with service to agriculture. Farming is still a way of living as well as a means of gaining a livelihood.

Each year new or special tasks arise at the Station; this was no exception. The European pine shoot moth, Stewart's bacterial wilt of sweet corn, the Dutch elm disease, a new "trouble" of peach trees—these and others of a minor character required intensive study and much time. The Entomology and Forestry departments have been called on to organize and direct the work of unemployed in the control of pests such as the blister rust, gipsy moth, mosquito, and pine shoot moth. All of these projects offer an opportunity for setting large numbers of men at work, but careful supervision is required. Coming at a time of reduced income, this extra endeavor has thrown an unusually heavy burden on the Staff and in some cases has interrupted progress on research projects.

Interest in potatoes as a cash crop has increased rapidly, especially as a substitute for tobacco. While we have learned much of tobacco fertilization on these soils, the growing of potatoes on them offers many problems. At the request of growers in the Connecticut Valley, a series of potato experiments was begun on a field adjacent to the Tobacco Farm at Windsor. In addition to fertilizer studies, demonstrations on the control of insects and diseases were included. The results were very satisfactory and the projects will be continued.

In keeping with the State's policy, every effort has been made to economize, without restricting essential services. To this policy the staff has given its whole hearted support. The budget on which we are now operating was planned without knowledge of the many new tasks

that have been assigned to the Station. Just what the outcome will be is uncertain but we hope to avoid a deficit. To the peach moth parasite breeding project the Pomological Society has pledged its support.

Here follow brief reports from the several departments on matters of greatest interest at this time. In spite of many handicaps, the regular Station program has gone forward without serious interruption. No better evidence of the efficiency and patience of the staff could be asked.

Progress of the Station's Work

Analytical Chemistry

Fertilizers. The report on fertilizer inspection for the season of 1933 appeared as Bulletin 355. A summary of data for the last 11 years shows that an increasing proportion of samples of mixed fertilizers supplying nitrogen, phosphoric acid and potash substantially meet or exceed guaranties in all respects. There has been also a considerable decrease in so-called commercial deficiencies. The following table illustrates these points:

Year	No. of samples examined	Substantially meeting guaranties in N, P_2O_5 and K_2O %	Commercial deficiencies of $1.00 or more per ton %
1923	261	55	17
1924	282	60	7
1925	255	67	13
1926	247	66	11
1927	243	68	7
1928	250	71	13
1929	239	72	9
1930	236	80	3
1931	235	74	3
1932	222	76	3
1933	199	76	3

Feeds. The regular annual report of inspection of commercial feeding stuffs was issued in April, 1933. The Department is frequently called upon to examine animal tissues or stomach contents in cases of sudden and unexplained deaths of farm animals. Such examinations are laborious and often no satisfactory conclusions as to the possible cause of death can be drawn. When lead, arsenic, or strychnine is found there is reason to believe that the animals have had access to paint, spray materials, or poisoned grain. In many cases, however, no evidence of the commoner poisons can be obtained and it seems probable that deaths can be attributed to poisonous alkaloids in forage plants. Water hemlock, sheep laurel, deadly nightshade and wild tobacco are known to be poisonous to animals. Two recent cases investigated by us (C. E. Shepard) prove or strongly suggest forage plants as the probable cause.

In one of these cases several animals died. Lead arsenate was suspected because the animals had had access to foliage that had been sprayed with that arsenical. No lead or arsenic was found but an alka-

loid giving the reactions of atropin was found in the stomach contents. Survey of the pasture disclosed a luxuriant growth of deadly nightshade and there was distinct evidence that its foliage had been browsed off. Atropin is a poisonous principle of that plant. In another case nicotine was isolated and identified in an examination of stomach contents of a cow. The pasture was not searched in this case but wild tobacco plants may have been the cause of death. Both of these cases are interesting from the laboratory standpoint, and the evidence in the first case was of very practical value because the circumstances strongly indicated that spray residue was the cause and the spraying company responsible.

Insecticides. Bulletin 346, a supplement to Bulletin 300, a compilation of analyses of insecticides, fungicides, bactericides and weed killers, was issued in February, 1933. Both of these bulletins have been useful for reference purposes and have been in considerable demand.

Foods and Drugs. Bulletin 354, the report on food and drug inspection for the year 1932, was issued in July, 1933. Considerable attention was given to the examination of fruits and vegetables for spray residues, chiefly arsenic and lead. Our experience to date indicates that spray residue is not a serious problem in this State. Very few instances of arsenic or lead in excess of the accepted tolerances have been found.

Since the early inspections of foods and drugs sold in this State, notable improvement in their quality has been observed. For example, the survey of spices made in 1897 showed that only 65 per cent of the samples examined were of satisfactory degree of purity. Of about 300 samples examined since 1920, 90 per cent have been found to be of standard quality. The first Station Report on drugs showed that only 40 per cent met the required standards and specifications; in the five-year period ending in 1931, 72 per cent were satisfactory.

Cooperative work. A considerable volume of analytical work has been done in collaboration with other departments of the Station; and members of the department staff have collaborated with the Association of Official Agricultural Chemists in studies of analytical methods.

Biochemistry

The chemical investigations of the tobacco plant have been continued, particular attention being devoted to the chemical changes that occur during curing and during culture of tobacco leaves in distilled water. The results of this study have been published in monograph form. Perhaps the most interesting of the observations made is that a rapid increase in the nitrate content of the leaves occurs both during curing and during water culture. The nitrate formed must arise from the oxidation of some other nitrogenous substance within the leaf tissue since no extraneous source of nitrate was available.

The nature and distribution of the organic acids of tobacco leaf have been investigated throughout the period of curing. It was found that a marked simplification of the organic acid picture took place inasmuch

as the proportion of organic acids of unknown nature diminished materially, their place being taken by citric acid. This acid increased at least six-fold in amount during the curing period. The results of this study are given in detail in Bulletin 352.

Much time has been devoted to the study of the methods for the determination of organic acids, in particular of the total acidity and of the three individual acids that predominate in tobacco leaf tissue, namely, oxalic acid, citric acid and malic acid. Convenient methods for the determination of all three have been developed. The method for malic acid is of especial interest inasmuch as it depends on a hitherto unknown reaction of this substance.

A new method for the determination of cystine in proteins has been developed and applied to a series of proteins. A satisfactory agreement between the results of this method and those obtained by other investigators working with other methods was obtained.

The nutrition investigations have included extensive studies on the basal metabolism of rats, and on the effects of rate of growth upon the skeletal development and the size of certain of the soft organs. In addition the comprehensive investigations of mineral metabolism and of the technic of colony management have been continued.

The laboratory has collaborated with the Association of Official Agricultural Chemists in the study of several methods useful in plant analysis.

Botany

Late blight on tomato (*Phytophthora infestans*). This blight appeared in the State in 1932 and was even more wide spread and destructive in 1933. Primary infections were found as early as September first. Infection took place on the leaves in contact with the soil and spread upward, eventually to the fruit. This observation was confirmed experimentally, with the use of infected soil. No evidence of infection through the seed has been obtained. Cultures were secured from the fruit but these produced conidia only, as with potato blight. A careful examination of many specimens, both living and dead, has failed to discover oöspores in any part of the plants.

Dutch elm disease. For several years a careful watch has been kept for the Dutch elm disease. Several cases of elms have been found affected by other fungi, *Cephalosporum, Verticillium* and *Sphaeropsis.* This fall, on the extreme southwestern border of the State, one tree yielded the *Graphium Ulmi* which is said to be the active fungus of the Dutch elm disease. Arrangements were made to have the tree destroyed. The federal agents have scouted the State, but no other cases have been reported.

Chestnut blight. The general survey for chestnut blight indicates that the spores are less abundant each year and the percentage of healthy seedlings and sprouts seems to be increasing. Also more reports of burrs are received. The oldest tree in the State, at Lebanon, has been fertilized and pruned in an attempt to keep it alive. The seedlings

planted at four locations in the State have suffered from competition and drought, but very few have died from the blight.

The accumulated records of the *Plant Disease Survey* have been prepared for publication as Part II of the Plant Pest Handbook for Connecticut.

Stewart's bacterial disease. Stewart's bacterial wilt on sweet corn was even more serious this year. So far no control treatment has been found entirely effective. Treatment of the seed gave rather poor results. The most promising lead is the use of resistant strains. Studies involving inoculation of healthy plants were conducted in cooperation with the Genetics Department.

Apple spraying. The apple spraying experiments have been directed at the problem of spray injury resulting from the use of substitutes for lead arsenate. So far there seems to be nothing entirely satisfactory. A series of tests with fewer applications is under way.

This year the Spray Service information was broadcast daily over three radio stations, from April 10 to June 15. The results of this service are being checked in one county.

The Botany Department is cooperating in an extensive investigation of a new peach trouble widespread over the state. Description of the Station's studies is given elsewhere in this Bulletin.

Seed analyses. Seed analyses under the statute and as a service to farmers required 395 germination tests and 200 purity analyses. Even with the excellent apparatus now installed, testing for purity is long and tedious. However, the effect of this inspection is shown in the constant improvement found in the quality of seed offered for sale.

As vegetable growing becomes more intensive, the control of diseases increases in importance. In an elaborate series of field experiments, new methods of control are being tested on all of the vegetable diseases causing serious trouble in the State. Of particular interest are the results with double strength Bordeaux. On potatoes this has given far better results than the single strength. Sprays in general are more effective than dusts.

Entomology

Oriental fruit moth. Control studies on the Oriental fruit moth in 1933 consisted chiefly in applications of oils and nicotine tannate on peach and quince. Fairly good control on quince, amounting to 47 per cent sound fruit, resulted from early sprays of lead arsenate, followed by late sprays of a pyrethrumized oil. Oil and nicotine tannate did not control the fruit moth on peach trees.

Mexican bean beetle. Further observations were made on the life history of the Mexican bean beetle, on the effect of spacing of plants, dates of planting and on tests of insecticides, the details of which have been prepared for publication. In general the infestation is less severe on plants 4, 6, and 8 inches apart than on plants 2 inches apart, and although the total yield is less, the yield of marketable pods may be greater. Early planted beans (May) gave a marketable crop without

the use of sprays. There was no particular difficulty in controlling the Mexican bean beetle by the applications of the recommended insecticides of magnesium arsenate and barium fluosilicate either as a spray or dust. Copper calcium arsenate dust gave good control and the non-poisonous dusts of pyrethrum and rotenone gave results only slightly inferior to those where poisons were applied.

Insect survey. This is a continuous project. Each year a few species of insects not before known to occur in Connecticut are collected, and 1933 has been no exception. A manuscript of about 150 typed pages has already been prepared for the Natural History Survey of the additions to the Check-List of Connecticut Insects (Bul. 31).

European pine shoot moth. Further records have been made on life history of the European pine shoot moth. Parasite counts in the New Haven area showed a low percentage of parasitism. Several shipments of introduced parasites were received from the Bureau of Entomology and liberated in New Haven and Fairfield Counties. Tests of sprays as a means of control were made in Middletown and North Branford and good results were obtained both with lead arsenate and fish oil, and with lead arsenate, nicotine sulfate, and penetrol. Clipping off the infested tips has been carried on as an experiment in New Haven and Meriden, and has been practiced widely in nurseries, and in forest plantations by owners or by men of the Civilian Conservation Corps Camps, all of which will give us useful data on the value of clipping as a means of control.

Potato flea beetle. Further life history notes were gathered in 1933, and control applications were made of barium fluosilicate, lead arsenate and fish oil, calcium arsenate, and Bordeaux mixture. Although results in the three field tests were not uniform all treated plots gave a larger yield than the check plots. Barium fluosilicate actually killed a good percentage of the flea beetles but most of the others killed only a small percentage and probably acted partly as repellents.

White apple leafhopper. Observations were continued and field experiments were conducted in control of the second generation. It was found that very satisfactory control of the nymphs could be obtained with nicotine sulfate, free nicotine, and anabasine sulfate—in water without the addition of soap. A number of pyrethrum preparations were also tried against the nymphs with good success.

Onion thrips. Observations have been made on onion thrips and spray tests conducted in Southington and Windsor, using nicotine sulfate, pyrethrum, and rotenone, all of which greatly reduced the thrips population in comparison with that of the checks. The sprays were only effective for a short period however, and some treatment having a more lasting effect is necessary if thrips are to be satisfactorily controlled by field sprays.

Spraying and dusting experiments. A comparison of the effects of calcium and lead arsenate in spraying and dusting is under way. One half the apple orchard at the Station farm was sprayed with one brand of calcium arsenate and the other half with lead arsenate. Then certain portions of each were treated with liquid lime-sulfur, dry lime-sulfur,

lime and fish oil, flotation sulfur, and Kolofog, as fungicides. Where no extra lime was added with fungicides, severe burn resulted. With extra lime this injury was slight. The burn was less on young trees than on older ones.

Study of lead arsenate substitutes. This study occupied considerable time. Demand for information regarding them led to investigation of calcium arsenates in four different orchards in the state. It was found that calcium arsenate, even the better grades, could not be used without lime, and should not be mixed with lime-sulfur solution. In two of the orchards combination of calcium arsenate with wettable sulfurs caused little or no foliage burn. In the Mount Carmel orchard there was burn from all applications of calcium arsenate, but this was more pronounced on some varieties than others. It is concluded that calcium arsenates need further study from the standpoint of spray burn before they can be generally recommended. Insect control with calcium arsenate appeared to be very good in this year's tests. Of the non-arsenical substitutes tried this year, synthetic cryolite appears to be the most promising. With this material insects were fairly well controlled and there was no spray burn. More than 94,800 apples (about 135 barrels) were examined in the course of the work.

Some experimental work with lead arsenate and other materials on peach trees indicates that barium fluosilicate, lead arsenate with zinc sulfate and lime added, and basic lead arsenate can be used without danger of burn. Severe burn resulted from applications of magnesium arsenate and potassium fluosilicate. The best control of curculio was obtained in the plots treated with barium fluosilicate, and standard lead arsenate with zinc sulfate corrective. Applications of oil and nicotine sulfate and nicotine tannate in August did not control the Oriental fruit moth.

Fruit moth parasites. Rearing and distributing parasites of the Oriental fruit moth was continued as in 1932. Applications for the service came from 227 peach growers owning 162,780 trees. In all, 276 packages were mailed. Together with the parasites placed in orchards by members of the staff for experimental purposes, this constitutes an estimated total of 28,300,000 Trichogramma; 4,656 Macrocentrus and 2,594 larval parasites belonging to four other species. Of the latter, 1,603 were obtained from the Federal Government laboratories and came originally from Japan. In addition, a species of Trichogramma from Europe was studied, but we were not successful in breeding it in quantities even though bagworm eggs were obtained from New Jersey for the purpose. Artificial breeding of Macrocentrus was continued and we were able to rear them at a rate of 17,000 per month or an average of more than 500 daily. Breeding of this parasite, however, was not so successful during late spring partly on account of difficulties encountered in maintaining suitable temperature and moisture conditions in the breeding rooms at this time of year.

Inspection of orchards and nurseries. The usual inspections have been made. Of nurseries there are now 365 in the State. Because of the European pine shoot moth all nurseries growing pine trees have been

re-inspected this fall and some of them have been visited three and four times. An attempt has been made to have this insect eliminated from all nurseries.

The gipsy moth. The control of the gipsy moth proceeded in the usual manner except that a troublesome infestation in Wolcott required much attention. It covered so much ground that it took a long time to scout the region, and also to spray it. The spraying season was short on account of rainy weather, so fewer infestations were sprayed than usual.

Altogether 54 towns were scouted, 96 infestations found, 17,719 egg-clusters creosoted, 17 colonies sprayed, 23.9 tons of lead arsenate used; 68,272 larvae and pupae were killed by hand and 1,214 miles of roadside and 13,782 acres of woodland scouted.

Just as the spraying season ended, in July, an important infestation was discovered at Groton Long Point where about 20 acres of oak and maple woodland had been defoliated. The egg-clusters will probably run into hundreds of thousands. Scouts are now cleaning up this infestation.

Under the Public Works Appropriation, Federal scouts are now at work and will cover the territory west of the Connecticut River including the Barrier Zone. Plans are now being perfected whereby the territory east of the Connecticut River will be scouted by men from the unemployed lists, paid out of the Civil Works appropriation.

Mosquito control. The usual maintenance work with a few extensions was carried on during the summer months. In October it was announced that Federal Civil Works appropriations for relief of the unemployed would be available to pay for labor to finish ditching the salt marshes, and plans are now being carried out toward that end. The authorization is for 1,200 men.

Apiary inspections. Apiaries have been inspected as usual but with a reduced appropriation. Consequently somewhat fewer apiaries were inspected in 1933, than were examined in 1932. However, the only disease found (American foul brood) occurred in a smaller percentage of the apiaries than in 1932. During 1933, 1,342 apiaries containing 10,927 colonies were inspected. Only 33 apiaries and 49 colonies were infested with American foul brood.

European corn borer. The only control work in 1933 has been the enforcement of the compulsory clean-up statute, carried out in about the same manner as in former years. On April 12, 22 inspectors checked over the entire state and issued 5,309 cards of which 970 or 14.5 per cent were not returned. The severe injury to early sweet corn in East Hartford, Glastonbury, Milford and Stratford, by the first brood larvae led us to have a survey of these localities made. In some instances this damage equalled 100 per cent, and averaged as high as 1,342 borers in 100 stalks, or 259,464 borers to an acre. A later survey of the second generation larvae was made and although the infestations did not run as high as in the first generation, there were several instances where the number of borers to an acre totaled between 75,000 and 130,000.

Asiatic beetle. Quarantine against the Asiatic beetle was revoked arch 1, 1933, and no control work has since been carried on. Advice s been freely given to property owners regarding the lead arsenate :atment to protect their lawns, and 36 inspections have been made of infested lawns.

Japanese beetle. Three hundred traps were placed in various portions of the State not then known to be infested. Beetles were caught in traps at Manchester, Middletown, and Putnam, the first time that these towns were known to be infested. In Bridgeport the beetles were so abundant that grapevines, Virginia creeper and roses were considerably injured. As usual, plants for shipment were inspected when necessary.

Forestry

The establishment of 12 camps of the Civilian Conservation Corps in Connecticut has materially affected the work of this department. Two members of the staff were loaned to the supervising staff of the camps, which resulted in some curtailment of our studies on the relation of soil characters to the growth of trees. The Conservation Corps, however, made available a supply of labor for use in control of forest pests and the year has been an active one along that line.

Blister rust. The work of eradicating wild currant and gooseberry bushes (Ribes) by State crews for the protection of the white pine against blister rust was curtailed this year, due not only to the reduced appropriation, but to the necessity for using available trained men on emergency projects. A limited amount of wild Ribes eradication work was done by State crews, and in addition the annual nursery sanitation work was carried on at nine nurseries. A cultivated Ribes survey was also completed in six towns.

The emergency work consisted of wild Ribes eradication under the Emergency Conservation Work program and the National Industrial Recovery Act. Approximately 200 members of the Civilian Conservation Corps were employed on eradication work in 19 towns. Under the National Industrial Recovery Act (N. I. R. A.) 80 men were employed locally in six towns in Litchfield County on wild Ribes eradication.

Approximately 250,000 wild currant and gooseberry bushes and 1,925 cultivated plants were destroyed, affording protection to the white pines on all the state forests and to many acres of natural and planted white pines on private lands.

White pine weevil. Two projects for forest insect control by the C.C.C. have been developed under the joint supervision of the Forestry and Entomology Departments of the Station. Control of the white pine weevil in certain definite areas was undertaken during the summer of 1933. About 1,500,000 white pine trees on areas totaling 10,000 acres in the vicinity of C.C.C. camps were inspected and all weeviled tops within reach were removed. Detailed records of this work were kept and it is planned to repeat the work in 1934 on the same areas if the men are still available.

European pine shoot moth. Control included inspection of all forest plantations of red and Scotch pine in Litchfield, Tolland, Windham, Middlesex and New London counties, and the eradication of infected bud clusters where found. Enough of the inspection work was completed during the summer so that the eradication work could be undertaken by C.C.C. crews beginning October 1. This will continue during the fall and winter so far as weather conditions permit, and will be pushed vigorously in the spring.

Except for the improvement cuttings referred to in the last report, very little work has been possible at the Rainbow forest during the current year. Owing to the other projects demanding attention, it has been impossible to secure the additional data needed for a progress report on the studies at Rainbow, and this publication must be postponed for another year at least.

Preservative treatment of posts. The experiments started in 1928 are beginning to show definite results and a progress report on the subject is in preparation. The serviceable life of untreated posts of white pine, poplar (Populus sp.), red maple, and gray birch is two to three years and of pitch pine four to six years. Treatment by brushing with creosote may be expected to add two to three years of service for these species. Posts treated by both the pressure and the open tank process are found to be sound at the end of five years of service.

The cooperative experiments carried on last winter with the State Highway and State Forestry Departments resulted in a new set of specifications for posts for guard rail and property fence construction being issued by the Highway Department. Hereafter such posts will be only of native woods, properly treated to secure adequate penetration of preservative. As the Highway Department is the largest consumer of posts in the State, this is a very important step toward better utilization of native forest products.

Further experiments to increase the efficiency and improve the technique of the open tank process will be carried on in cooperation with the State Forestry Department on the Meshomasic Forest at Portland. The experimental plant will be part of a commercial plant, to be constructed and manned by the Conservation Corps as a means of utilizing material cut by the crews during the coming winter. Much additional data should be secured from this source.

Forest planting stock. The distribution of forest planting stock continues to show the effect of unfavorable economic conditions. The total of 873,000 trees sold to Connecticut land owners in 1933 is 12 per cent less than that for 1932.

Genetics (Plant Breeding)

Resistant sweet corn. Out of 80 commercial varieties of early yellow and white sweet corn tested on the Mount Carmel farm, none were found to be free from serious injury by Stewart's bacterial wilt. Spanish Gold has been found to be somewhat freer from injury in Connecticut than

other varieties ripening in the same season. Several crosses of Spanish Gold with inbred strains of Golden Bantam and of Whipple's Yellow have shown no infection in preliminary trials. Although the number of plants grown was small, these preliminary trials indicate that early corn can be obtained comparatively free from damage by this disease.

Out of a large number tested, a few inbred strains of Spanish Gold, Golden Early Market, and Golden Sunshine have been found with very little or no infection when the seedlings were artificially inoculated in the greenhouse. The same strains are, for the most part, equally free from infection in the field. It is planned to use these strains in the production of varieties resistant to bacterial wilt.

Some of the first generation hybrids of inbred strains of Whipple's Yellow sweet corn that have produced well in previous trials, have been found to be quite susceptible to bacterial wilt. The tests carried out during the past season both at Mount Carmel and at Windsor have shown certain combinations to be outstanding in showing very little injury from this disease. Some of these resistant combinations were well-eared and otherwise desirable for market garden purposes.

Ensilage corn. In three years' trial of ensilage corn, late southern varieties such as Cocke's Prolific, Pamunkey, and Virginia Eureka have produced the most dry matter to the acre. All of these varieties during the past three years have reached at least the dough stage. Later varieties such as Tuxpan that produce no mature grain have less total dry matter. Earlier varieties that produce ripe ears and give good grain yields, such as Sweepstakes and Lancaster Sure Crop, yield even less total dry matter than the latest varieties obtainable. The past three seasons have been warmer and the period of growth somewhat longer than the average so that the later varieties may not be expected to make such a good showing every year. Nevertheless they are being grown and should receive even more consideration where the most food value to the acre is desired.

Genetic studies. Additional material was grown for the study of the two lethal factors causing the disturbance in the ratio of starchy and sweet kernels on ears segregating for the *Su su* gene. The two factors responsible for this disturbance are very closely linked to the *Su su* locus (about 2 to 3 per cent crossing over).

One factor, lethal ovule, causes practically all ovules carrying it to abort and this eliminates either the *Su* or *su* ovules, depending on the one with which it is linked. This gene is transmitted almost entirely through the pollen.

The other condition, small pollen, causes one-half of the pollen grains to be much smaller than normal pollen grains. The small grains cannot function in competition with normal grains and hence are lost. This results in an elimination from the pollen of practically all of the *Su su* genes, the one associated with small pollen being excluded. This condition is transmitted almost entirely through the ovules.

We now have ears in which the lethal ovule *Lo lo* and small pollen *Sp sp* are linked each with the starchy *Su* and sugary *su* genes. Entirely different ratios are produced by the *Lo lo* and *Sp sp* factors. The linkage is well established for the *Su su* gene, and this last summer ma-

terial was grown for testing the linkage with other factors on the *Su su* chromosome.

Vegetables. The vegetable strain trials at Windsor show marked variation from year to year in the performance of the same varieties due to the differences in seasonal conditions. A few varieties seem to have the ability to yield well nearly every year and in other respects are desirable. Such varieties can be recommended to Connecticut growers for trial on their own farms. This is notably true for lettuce, beets, tomatoes and peppers. The results of all trials are given in Circulars 82, 87 and 94, entitled "Testing Vegetables for Connecticut", in a series for 1931, 1932 and 1933.

At Mount Carmel particular attention is being given to methods for improvement by breeding of lettuce, beets, carrots, squash, peppers, tomatoes, lima beans, and sweet corn. An especial effort is being made to produce a lettuce that will head late in the season from seed sown directly in the field. Growers want greater uniformity in root crops. The transmissable factors controlling variation in shape, color, and rapidity of growth of beets and carrots are being studied. Promising selections of squash, peppers, and tomatoes are also in process of development.

Strawberries. About 400 selected seedling strawberries from crosses of inbred strains of Howard 17, Chesapeake, Glen Mary, and Progressive are being grown in their second trial. Some of these have outstanding characters of desirable fruit and productiveness, but must be tested under a wide range of conditions to determine their adaptability and usefulness for Connecticut.

New strawberry varieties are being tested in comparison with old standards for yield, quality of fruit, and time of ripening. These include Dorsett, Fairfax and Catskill, three new varieties of unusual promise.

Raspberries. It has been found that black raspberries show very little reduction in vigor when inbred. Two inbred lines, self-fertilized for three generations, are as uniform grown from seed as the original vegetatively propagated variety, and as productive. Further trials are being made and seed is available in limited amount for testing. The seedlings must be started in flats or cold frames, but when once growing are as easy to handle as tip layers. Being produced from seed they have the advantage of starting free from virus infection.

Soils

Greenhouse fertilization trials. During 1933 a series of 11 soils from alfalfa fields of the State have been investigated for fertilizer requirements, using tobacco as a test crop for soil deficiencies, as in former years.

In spite of the previous growth of alfalfa on these soils, all of them showed significant responses to nitrogen. Yields without nitrogen ranged from 28 to 53 per cent of those on pots completely fertilized, with an average of 40 per cent.

While the soils had received some phosphatic fertilization when seeded to alfalfa, all were still seriously deficient in phosphorus. Yields without phosphorus ranged from 20 to 65 per cent, averaging 49 per cent. Four vegetable crop soils by the same scheme of evaluation ranged from 69 to 86 per cent crop in the absence of phosphorus, during the previous year's trials.

Potash deficiency was especially marked on this series of soils, with one exception. Ten of the 11 soils gave yields without potash ranging from 15 to 46 per cent, averaging 31 per cent. The four vegetable crop soils ranged from 53 to 73 per cent in the absence of potash.

It is apparent that alfalfa fields, seeded on average soils, treated with about 600 pounds of superphosphate and 200 pounds of muriate of potash to the acre at the time of seeding, are deficient in phosphorus after alfalfa has been grown for a few years, and there is evidence that alfalfa crops tend to deplete the available potash in the soil to a significant degree. Crops requiring a considerable amount of readily available nitrogen cannot depend upon the residual nitrogen left in the soil by alfalfa to supply their requirements.

Soil testing service. During the past few years, a series of simple and reasonably accurate soil tests for the active constituents concerned in plant nutrition has been developed at this Station. The technique involves the extraction of the soil with a sodium acetate-acetic acid buffer mixture, designated as the "Universal" soil extracting solution, and subsequent tests of this extract for the following: Nitrate nitrogen, ammonia nitrogen, phosphorus, potassium, calcium, magnesium, aluminum, manganese and iron. During the 1933 season more than 1000 samples of soil from fields, gardens, lawns and golf courses of the State have been tested by these methods, and recommendations of treatment have been made on the basis of these tests and on conditions of soil reaction, soil type, drainage and crop requirement. The tests are being constantly studied on soils of known nutrient deficiency, and the series of more than 100 soils upon which crop response data has been obtained by means of pot tests during the past eight years furnishes a suitable basis for the correlation of results of the chemical tests.

Lysimeter experiments. The series of lysimeter experiments to show the effect of heavy applications of various nitrogenous fertilizers upon the drainage losses of various soil constituents is now in the fifth year. Important soil changes have taken place as a result of the differences in effect of the forms applied, and these will be studied in detail at the close of the five year period.

The series of lysimeters started in 1931 to show the effects of cover crops in conservation of plant nutrients against leaching indicated an average annual saving of about 56 pounds of nitrogen, 44 pounds of calcium, 24 pounds of potassium, and 8 pounds of magnesium per acre during 1931 and 1932 when oats were grown as a cover crop between tobacco crops. The fall of 1933 has been unusually dry at Windsor, and no drainage losses have occurred under oats, as compared with the equivalent of about 0.75 acre-inch of water leached in the absence of cover crop.

Forest soil studies. A set of six shallow lysimeters were recently installed in a red pine plantation in Woodbridge for the purpose of determining what nutrient materials are leached out of the humus and upper mineral soil. Although the experiment must be carried over several seasons before conclusive results can be obtained, the lysimeters have already demonstrated the value of forest litter in absorbing rainfall. Of the total precipitation between April and November, about 65 per cent reached the ground and was absorbed by the soil covered with needle litter, while only 35 per cent was absorbed by the bare soil.

The soluble nitrogen content of the water that had leached through the soil was considerably higher in the fall, even in mid-November, than it was in June and July. This helps to explain why tree roots continue to grow so late into the fall. Growth of the tree above ground takes place in the early summer and is dependent to a considerable extent upon the food reserves taken up by the roots the previous year.

The composition of forest leaves changes rapidly after they fall and become subjected to the leaching effect of rains. In the first seven weeks about three-quarters of the potassium and from 12 to 50 per cent of the phosphorus were lost. If the full manurial value of raked leaves is to be conserved, they should be collected and put on a compost pile as soon as possible after they have fallen.

Studies on moisture distribution under trees have shown that tree roots go a long way for water if necessary. In a coarse sandy soil they may draw upon the soil two or three times as far as the branch spread. Close to the base of the tree, moisture is removed fairly uniformly to a depth of four feet or more, but the lower limit of the depleted region gradually becomes shallower with increasing distance from the tree base. Roots were encountered 30 feet from a red oak tree only 22 feet tall. The amount of rainfall that reaches the ground under a tree averages between 40 and 80 per cent of the total precipitation, varying with the intensity and duration of the rain and the direction from which it comes.

Fertilizer tests with red pine indicate that the plant food requirement of that species is quite low in comparison with that of the ordinary farm crop. Nevertheless, on poor soil growth may be increased by using fertilizers in the seed bed and transplant bed.

Seedlings grown at New Haven in a highly fertilized tobacco soil brought from Windsor were more than 50 per cent larger than those grown in coarse sand from Rainbow. Considerable care to prevent injury must be exercised in using some fertilizers such as sulfate of ammonia and nitrate of soda. Dried ground fish, blood tankage, bloodmeal, Nitrophoska and Milorganite are some of the materials used that have been beneficial with a fair degree of consistency. Some of the trees that have been fertilized in the nursery have been planted in the field and their future growth will be observed.

Fertilizers applied to red pines five to seven feet tall had not, at the end of the second growing season, caused any definite increase in growth, nor had they altered to any appreciable extent the composition of the needles.

Duration of liming effects. In the spring of 1927, a series of 48 concrete walled soil plots were filled with uniformly mixed soil and subsoil. This soil was strongly acid, with the reaction of 4.99 pH when the experiment was started.

Lime was applied to 24 of the plots at the rate of four tons of calcium carbonate to the acre, and thoroughly mixed with the soil to a depth of six or seven inches. No liming material has been used since that time.

Soil reaction (pH) has been measured at monthly intervals for more than six years. The somewhat excessive original liming raised the pH during the first year above the neutral point. Since that time there has been a general downward trend, compared with the unlimed treatments, as shown in the following table:

MEAN ANNUAL pH VALUES
(June 1 to May 31)

	Unlimed	Limed	Difference due to lime	Annual change
First year	4.96	7.53	2.57+	....
Second year	5.05	7.01	1.96+	.61—
Third year	4.75	6.44	1.69+	.27—
Fourth year	4.86	6.42	1.56+	.13—
Fifth year	4.97	6.28	1.31+	.25—
Sixth year	4.93	6.14	1.17+	.14—

It is apparent that the difference between limed and unlimed treatments is becoming less each year, and by interpretation of the past trend in the future it may be shown that in about 20 years there should be less than 0.2 pH difference between limed and unlimed soil, which represents the disappearance of significant effect by usual standards of measurement.

However, in the seventh season after liming, an excellent crop of barley, an unusually acid-sensitive cereal, was produced on completely fertilized lime plots at a reaction of 5.82 pH at harvest time. A practical failure was shown on the unlimed plots receiving complete fertilizer (Reaction — 4.76 pH).

Market garden fertilizer trials. In the past four years two acres of a light sandy loam (Merrimac series) have been intensively cropped to various market garden vegetables, in a series of fertilizer plots. Three crops are grown in two years on the same field.

Under this system of cropping it has not been possible to grow a sufficiently heavy green manure crop (rye, or rye and vetch) during the idle period from late fall to early spring to maintain productivity on the same level as attained by the use of a moderate amount of manure in conjunction with fertilizer treatments. Twenty tons of manure and 750 pounds of a commercial fertilizer supplying 45 pounds of nitrogen, 50 pounds of phosphoric acid and 60 pounds of potash to the acre, has given the maximum return for practically all crops. Forty tons of manure, without commercial fertilizer, has been inferior for early spring crops, and, except in case of a few late planted crops in dry seasons, has not

produced as well as when half of this quantity of manure was replaced by the fertilizer application.

A larger application of fertilizer, supplying 90 pounds of nitrogen, 100 pounds of phosphoric acid and 120 pounds of potash, with as much green manuring as has been practicable, has failed to produce as good crops as obtained by the smaller amount of fertilizer with stable manure. However, reasonably good early and midseason crops have been consistently produced each year without stable manure. Crops seeded after July 1, following early crops, have been very unsatisfactory when no manure was used. It must be considered that unusually dry conditions have prevailed in the late summer months during all of the years of the experiment.

In comparisons between types of commercial fertilizer, there has been little or no consistent difference, for the season as a whole, when equivalent quantities of fertilizer elements were used. A highly concentrated formula made up from potassium nitrate, urea, and ammonium phosphate has given equal results with a formula containing castor pomace, superphosphate, sulfate of ammonia, nitrate, and sulfate of potash. The concentrated formula was slightly more effective on early planted crops, and was slightly less beneficial on late crops. This was also true of a formula made up of sulfate of ammonia, tankage, superphosphate, and muriate of potash.

The addition of extra nitrogen as a top dressing was beneficial in the majority of cases, particularly with early crops. There was no significant benefit from using more than 120 pounds of potash per acre on this soil.

Half-rate fertilizer applications, as compared with full treatment, both in the absence of manure, has caused a significant decrease in yield on all early and most late seeded crops, but has produced nearly equally good yields on sweet corn, peppers and squash. Tomatoes and cucumbers have done significantly better on the full fertilizer treatment.

Plots receiving no lime, as compared with all other plots that have been limed in 1930 and in 1932, have consistently failed to produce satisfactory crops of lettuce, spinach, radishes, beets, and carrots, and the differences due to lime have become more striking during the past two years. The other crops, including sweet corn, tomatoes, peppers, squash, string beans, lima beans, cucumbers and onions, have showed no significant differences due to liming. The reaction on the unlimed plots is only moderately acid, (5.2 to 5.6 pH).

Tobacco Substation

Cause of seed bed failures. The spring of 1933 was marked by an unusual number of failures of seed beds to produce enough plants for setting. Many beds were completely abandoned because not enough plants were left to pay for further care. This was not due to lack of seed germination but the plants began to disappear as soon as the first tiny leaves (cotyledons) were visible and every day the stand became

thinner as more seedlings died. This condition, which appeared like an epidemic for a few weeks, was prevalent in all parts of the valley and in all three types of tobacco. It was worse in steam sterilized beds than in unsterilized. The cause was found to be a parasitic fungus (Pythium) which spreads with extreme rapidity, especially in previously sterilized soil, and kills the plants within a few hours. The fungus has been isolated and thoroughly investigated in the laboratory. Application of formaldehyde dust to the soil has given fair control in greenhouse tests, but its application to field conditions has yet to be determined.

Nitrogen fertilizer experiments. The major part of the land available for fertilizer experiments on the Station farm is now devoted to nitrogen test plots. These are divided into four series:

1. Optimum total quantity of nitrogen. Five increments from 100 to 300 pounds per acre are under comparison.

2. Comparison of single sources of nitrogen. Cottonseed meal, castor pomace, corn gluten meal, linseed meal, dry ground fish, urea, sulfate of ammonia, nitrate of soda and cal-nitro are each used year after year on the same plots as the only source of nitrogen on their respective plots. The effects on yield, grading and leaf characters are determined. Most interesting is the effect of sulfate of ammonia when used for seven successive years on the same soil. This soil is now excessively acid (3.91 pH) and the tobacco was a total failure in 1933. Nitrate of soda in recent years has been applied in four or five successive applications during the growth of the plants and under these conditions has given good results. Urea at the end of seven years is beginning to show adverse effects similar to those of sulfate of ammonia. Differences resulting from the several organic materials are insignificant.

3. Value of nitrates in the mixture to serve as a "starter". Various combinations of organic nitrogen materials with and without such a starter are under comparison on Broadleaf and on Havana seed tobacco.

4. Value of combinations of materials as compared with single sources of nitrogen. Various combinations of nitrogenous materials are compared with single sources in the mixtures.

Rates of transformation of the nitrogenous materials to available compounds in the soil are determined by weekly soil tests. Rates of intake and assimilation in the plant are determined also by frequent chemical analyses of the green plants.

Placement of fertilizer in the row. It is the common practice of tobacco growers to broadcast the fertilizer evenly over the soil before setting. It has been shown with crops other than tobacco that equally good results can be obtained by using less fertilizer if it is applied in the row instead of being spread over all the surface of the soil. In order to learn whether the same saving of fertilizer can be made in growing shade tobacco the quantity was reduced on successive plots to 7/8, 6/8, 5/8 and 4/8 of the usual broadcast application. No differences in growth were observed in any of these plots in the field. The sorting results however are not yet available and conclusions cannot be drawn until the grading shows what effect, if any, such reductions have had on the percentage of grades and quality of the leaves.

Improvement of Havana seed strains. This work, in cooperation with the United States Department of Agriculture, began in an attempt to find strains of Havana seed tobacco that are resistant to black rootrot. To that extent the project was successful and we now have a number of strains that show satisfactory resistance. The next important problem was to learn which strains are the most satisfactory in quality from the manufacturer's standpoint and in yield from the farmer's viewpoint. As far as yield is concerned, repeated tests have shown that they will produce more than the ordinary strains. The judgment of the manufacturers has also been favorable on a number of them.

Soil nitrification studies. Studies of the effect of various nitrogenous fertilizers on nitrate production and soil reaction were continued on the single source of nitrogen plots. The general level of nitrate production was low during the entire season, because of inadequate rainfall. Irrigation failed to stimulate nitrification, in contrast to a natural rainfall in early July, which was followed by a moderate increase in nitrates. Soil nitrates had practically disappeared by the middle of October.

Soil reaction was determined concurrently. The acidity increased during the summer, reaching a low point of pH 3.39 on the sulfate of ammonia plot. Readings of pH 6.21 and pH 6.25 were found on the nitrate of soda plots in early spring and late fall.

Diagnosis of nutrient deficiencies in tobacco soil. The tobacco plant is a heavy feeder on nutrients in the soil, and although relatively large quantities are applied annually to the Connecticut Valley tobacco fields in the form of fertilizers, frequently the grower observes that parts of his fields produce unsatisfactory growth in one way or another. We are often called upon to advise the grower as to possible remedies for the troubles. Sometimes a simple determination of the reaction will show whether the soil is too acid or not acid enough and it is then a matter of lime or no lime. Such soil testing service the Tobacco Station has rendered the growers for a number of years.

However, in cases where the reaction is satisfactory and the soil still produces unsatisfactory growth, other causes must be sought. Through the work of the soils laboratory at New Haven we now have microchemical soil tests for rapid diagnosis of soil deficiencies. Considerable work has also been done on nutrient deficiency symptoms of plants. Work is now under way at this Station to adapt microchemical tests to our special problems and to correlate the chemical tests with the growth and appearance of tobacco plants.

Conservation of plant nutrients by cover crops. Field tests for five years have shown that the use of winter cover crops has improved both the yield and quality of tobacco. It is reasonable to suppose that this improvement may be partly explained by the quantity of plant nutrients which are retained by the cover crop and thus prevented from leaching away during the fall, winter and spring rains. In order to measure the extent of such conservation, cover crops were sowed in lysimeter tanks and the water that naturally leached through the cropped soil was analyzed for nutrients and compared with the leachate from uncropped tanks. In this way it was found that a cover crop of oats saves annually

56 pounds of nitrogen, 62 pounds of lime, 28 pounds of potash and 13 pounds of magnesia to the acre.

Tobacco insects. Barium fluosilicate dust was used commercially this season on several hundred acres of shade grown tobacco and proved quite satisfactory as a control measure for the potato flea beetle on tobacco. Diluted 1 to 5 (by volume) with tobacco dust and applied at a rate of five pounds of barium fluosilicate to the acre, excellent results may be obtained. Other dusting materials are also being tried.

The use of calcium cyanide against wire worms again demonstrated the efficiency of this material when drilled into infested soil at a rate of 100 pounds to the acre.

Observations of the life cycle of wire worms are being continued.

Studies on the control of tobacco thrips indicate that sprays are more effective than dusts.

Special Investigations

A New Peach Trouble

A special investigation was begun in August of a seemingly new peach trouble which at that time was known to occur in several orchards in the State and was severe enough to cause some alarm among the owners.

The trouble is characterized by a premature yellowing and ripening of the foliage on a part of the branches at midseason or later, and is usually accompanied by a falling of the injured leaves and of the fruit on these particular branches. The fruit that remains on the tree appears normal but perhaps ripens a little earlier. There is also in the wood of the injured branches a characteristic dark brown streaking, extending longitudinally through the branch, these streaks frequently arising from a cut end of a branch or a cut-off side branch. The twig growth and bud formation on the branches from which the leaves have fallen appear normal and in the winter it is very difficult, if not impossible, from the external appearance, to distinguish between healthy and injured trees.

A careful survey was made of sixty-three orchards scattered throughout the State, and as complete records as possible were obtained of the past history of each orchard, as to source of trees, varieties, age, spraying, cultivation and any other particulars that could be learned. Maps of the whole or a part of several of these orchards were made, so that in 1934 the spread of the trouble, if any, can be determined. In 62 of the 63 orchards visited the trouble was found to be present in varying amounts, affecting from one per cent to 100 per cent of the trees, mostly ranging around five per cent.

Temperature and rainfall records for a period of years have been plotted and studied with the thought that weather conditions might be a contributing factor. The last five years have been decidedly abnormal. It is very evident that drought has caused a decided decrease in annual ring growth but what other part weather conditions play is still uncertain, although it is possible that the metabolism of the trees has been unbalanced to such an extent as to render them susceptible to the in-

vasion of fungi or to injury from other causes which would have no effect on normal trees.

A quantity of seedlings were budded with buds from injured trees to determine the possible presence of a virus disease. The results of this experiment will not be known for at least a year. Healthy trees were injected with expressed juice from healthy and injured trees to determine if there was any toxic principle in the sap of the injured trees. **The results were negative.** The water conductivity of the wood from healthy and abnormal trees was tested and it was found that the healthy wood conducted more water than the wood from the injured trees, but what bearing this has on the problem was not determined. Some chemical analyses of wood and bark from the abnormal trees showed an appreciable amount of arsenic. However, these data were not sufficient to warrant any conclusions.

Much material has been examined for fungi and in all cases a fungus or fungi have been found in the streaks in the wood. Cultures from all the material have been saved and inoculations of healthy trees in the greenhouse were made. No results have as yet been obtained from these inoculations so it is not yet known what part the fungi may have in causing the injury.

Increment borings were taken from healthy and injured trees and these show that all the trees had made approximately the same normal annual ring growth until 1930, which was a year of severe drought. In 1930 all the trees showed the same decided decrease in annual ring growth. In subsequent years the data at hand show a tendency for the healthy trees to put on increased growth, while the injured trees still show a static or decreasing rate of growth. Considerable material from these trees has been sectioned in an attempt to discover deformations of the wood caused by freezing or any other adverse climatic condition, but so far with negative results.

Soil samples were taken from all the orchards examined and to date the soil type or the condition of the soil as indicated by chemical analyses, have shown no correlation with the presence of the injury. Greenhouse pot experiments with soils from a number of orchards are now in progress.

In the late fall observations and reports indicated a seeming recovery in some of the orchards most seriously affected, at least if development of buds on the injured branches may be so interpreted. Later still, the low temperatures of Christmas week caused great injury to the fruit buds which may introduce a disturbing factor in this investigation.

Potato Experiments at Windsor

On a two-acre field adjacent to the Tobacco Station, a series of potato experiments was begun, involving fertilizer practice and the control of insects and disease.

Fertilizer experiment. Many fields formerly in tobacco for years, and heavily fertilized, are being planted to potatoes. In order to ascertain

the fertilizer requirements of potatoes under these conditions, a series of 70 one-fortieth acre plots was established in the spring of 1933 on a field which had been under tobacco fertilization for a long period.

Preliminary soil tests on this field showed a high content of active phosphorus and a moderate content of active potassium, which is characteristic of old tobacco land. A low magnesium test was obtained.

Varying rates of application of phosphorus, potassium, magnesium, and nitrogen were included. The standard treatment supplied 100 pounds of nitrogen, 120 pounds of phosphoric acid, 120 pounds of potash, 60 pounds of lime, and 40 pounds of magnesia, with all of the nitrogen as sulfate of ammonia. Green Mountains were used and on this standard treatment yielded 376.6 bushels of marketable size, and 12.2 bushels of culls, per acre.

Varying applications of phosphoric acid and potash gave no significant differences in yield. There was a slight indication that the yield was somewhat decreased by omitting magnesia, and there was a slight decrease when the nitrogen application was reduced by 50 per cent. The following data are indicative of the results obtained:

	Yield marketable potatoes (bu. per A.)	Probable error (bu. per A.)
No fertilizer	279.4	...
No magnesia	351.2	15.4
Half rate nitrogen	358.8	5.9
No potassium	369.3	7.7
Standard treatment	376.6	7.7
No phosphorus	385.8	11.5

On the basis of the results for the first year, it appears that there were sufficient amounts of residual phosphoric acid and potash remaining from previous tobacco fertilization to supply the needs of the potato crop, and it is evident that on old tobacco land there is no necessity for using as large amounts of these ingredients as are customary in potato fertilization (2000 pounds of 5–8–7 supplies 160 pounds of phosphoric acid and 140 pounds of potash).

A continuation of this experiment should reveal the duration of residual fertilizer effects. From similar studies on tobacco it is anticipated that significant increases will be obtained from potash applications in 1934 on this field.

Spraying and dusting. This report contains the results of a demonstration of the relative effectiveness of certain insecticides and fungicides used in the culture of late potatoes, carried out at Windsor in connection with the soil-fertility experiments.

The materials used in the demonstration test were: barium fluosilicate one pound, lime five pounds, applied as a dust; copperlime dust; 4–4–50 Bordeaux mixture; 8–8–50 Bordeaux mixture; and arsenate of lead three pounds, fish oil one quart, water 100 gallons, as a spray. Each treatment was applied to five rows 75 feet in length and an untreated plot of five rows was retained as a control. Six applications of all of the above materials were made on the following dates: May 29; June 8,

19, 30; July 18, 28. On August 18, the only plots showing sufficient green foliage for further treatment were the two plots which had received Bordeaux sprays and these were given the sixth and last application on that date.

During the first part of the season, early blight was present on the check, dusted, and arsenate of lead and fish oil plots. Late blight was found on a few leaflets at the time of digging, October 5, but no late-blight rot was found on the tubers in any of the plots.

The potato flea beetle was abundant during June and caused considerable damage. Later in the season it was not so destructive. Leafhoppers were moderately abundant during the late summer, and some tip burn resulted from their feeding. The Colorado potato beetle was not present.

The yields of potatoes from the various plots are given in the following table:

Treatment	Yield—Bushels per acre		Increase over checks (Firsts)	
	Firsts	Seconds	Bushels per acre	Per cent
Control	176	23	..	..
Lead arsenate—fish oil	216	13	40	23
Copper-lime Dust	225	16	49	28
Barium Fluosilicate	227	16	51	29
4–4–50 Bordeaux	376	12	200	115
8–8–50 Bordeaux	404	7	228	130

In this table the various treatments are listed in the order of their effectiveness in increasing the yield of tubers. The lead arsenate and fish oil spray and barium fluosilicate dust were used primarily for the control of flea beetles. Since the increases in yields with these materials amounted to 40 and 51 bushels per acre respectively, the usefulness of these insecticides for flea beetle control is demonstrated and these figures also show the proportional amount of damage due to this insect. The copper-lime dust treatment was found to be much less effective than Bordeaux mixture in obtaining increased yields of potatoes. The outstanding increases in yield of 200 bushels or more per acre obtained by the Bordeaux sprays are due to: prevention of flea beetle and leafhopper injury, protection against climatic conditions unfavorable to the potato plant, and stimulation of the plant resulting in increased tuber production.

A comparison of the yields from the two strengths of Bordeaux mixture shows a difference of 28 bushels per acre in favor of the 8–8–50 spray. The yield of 404 bushels of first grade potatoes from the 8–8–50 Bordeaux plot was the highest of all the yields from the various treatments used in the demonstration. This plot also produced the smallest amount of second grade tubers.

Electrically Heated Hot Beds

In connection with the market garden trials at Windsor, a series of hot beds with electrically heated cables for temperature control were installed during the fall of 1932. The beds were divided into three

sections, each controlled with a separate thermostat. Each section consisted of eight sash equipped with two heating units (120 ft. cable) for each four sash.

In connection with this work, a sand propagating bed for the establishment of cuttings was laid out in order to determine the possibilities of utilizing the hot bed space in this way during the early winter months. Excellent results were obtained, especially on certain ornamental hardwood shrubs from which cuttings are difficult to produce under ordinary greenhouse conditions. Carnations, verbenas, arbor vitae, grapes and eleven species of hardwood shrubs were successfully propagated in this manner.

During November and December, 1932, head lettuce was grown in the electrically heated beds, under three conditions:

1. Wafer type thermostat, in air space above soil, set at 40° F.
2. Soil thermostat, set at 60° F.
3. Soil thermostat, set at 70° F.

The plants matured very slowly and produced small heads at the 40° minimum air space temperature, indicating too cool conditions. Best heads and highest percentage of heads were developed at 60° F. soil temperature. At 70° F. soil temperature, growth was too rapid to produce good heads, and at the later stages the plant tissue broke down rapidly.

Beets were also grown in flats from seed, during early winter.

In late winter and early spring cauliflower, lettuce, tomatoes and pepper plants were started for later transplanting into the field. In April and May sweet potato plants were started at 80° F. minimum soil temperature.

In order to show maximum current consumption, data for December, 1932 gives an excellent representation. The average temperature for the month was 32.5° F., with an average daily minimum of 24.3°. An extreme minimum of six degrees below zero occurred on December 17. The average daily current consumption was 0.875 Kilowatt hour per sash, costing, at two cents per K.W.H., one and three-quarters cents. Maximum daily current consumption for 24 sash was 38 K.W.H., on the coldest day.

Sweet Potato Trials

In response to a demand for more specific information on sweet potatoes under Connecticut Valley conditions, this crop has been grown in a small way in variety trials at Windsor during the past three years. In 1933 this work was expanded to include fertilizer experiments, comparisons with white potatoes and curing technique.

The following are comparative yields of sweet potatoes (Yellow Jersey) and Irish potatoes (Green Mountain) in the dry season of 1933, under those treatments which showed significant results.

Treatments, per A	Yield of marketable potatoes in bushels per A.	
	Sweet	*Irish*
40 tons manure	308	377
20 tons manure and 750 pounds 6–7–8 fertilizer	278	342
1500 pounds 6–7–8 fertilizer	229	310
750 pounds 6–7–8 fertilizer	189	295

The omission of lime in this moderately acid soil did not produce a decreased yield of either crop.

Sweet potatoes showed an apparent benefit from increasing the potash application from 120 to 180 pounds per acre. No definite conclusions should be drawn from the results of a single season.

In order to store sweet potatoes for any length of time, the skins must be dried down by placing the potatoes in a warm, dry place for several days, as soon as possible after harvesting. The crop grown at Windsor was thus cured in a section of a tobacco shed which was partitioned off so as to close as tightly as possible. The potatoes were racked up in bushel baskets set on boards across the beams used for the tobacco lathes. Charcoal fires were kept up in an open space between the racks for seven days, maintaining a temperature of about 85° F. After five days, humidity records indicated that the potatoes had ceased to contribute significantly to the moisture of the air within the chamber.

This process, with chambers utilized to their full capacity, would cost approximately five cents per bushel. The potatoes thus cured have since kept without serious storage losses in a dry room at moderate temperatures, (45 to 50° F.)

The report on the several varieties grown in 1933 will be found in Circular 94, "Testing Vegetables in Connecticut".

The Library

During the year ended October 31, 1933, the Station Library has had approximately the following number of additions:

U. S. Department of Agriculture bulletins and reports	644
State Agricultural Experiment Station publications	1165
Scientific and agricultural domestic and foreign journals	3000
Single books purchased	68
Total	4877

The library subscribes to 85 sets of scientific journals. It receives in exchange for its own publications about 20 sets of domestic farm journals and 15 sets of foreign agricultural journals.

The total number of cloth and paper bound volumes on hand is now about 17,400. Most of the United States Department of Agriculture and State Experiment Station publications are received in pamphlet form and are not included in the volume count until bound.

Field Days and Exhibits

Approximately 350 farmers and their families attended the annual field day at Mount Carmel on August 16. Dr. F. J. Sievers of the Massachusetts Agricultural Experiment Station addressed the gathering in the big tent at noon on "The Sins of the Farmers".

Station people were posted at the various experimental plots to explain the projects to the visitors. Interest centered around the experiments of the plant breeding department to control the inroads of Stewart's disease by breeding resistant strains of sweet corn. The farmers were shown certain crosses resistant to the wilt in the midst of sickly plants.

Another important exhibit was the demonstration in control of the Mexican bean beetle. The Station investigators were able to show clean beans as a result of a careful spray schedule and wider spacing of the plants.

The visitors were also shown the effects of various substitutes for lead arsenate which were being tried out in an effort to avoid harmful spray residues.

On August 10, the annual twilight meet of the vegetable growers was held on Windsor field. The Hartford County Market Gardeners Association and the Hartford County Farm Bureau cooperated with the Station in holding this meet. The growers made careful inspection of the vegetable fertilizer studies, the breeding experiments and the tests of various strains.

In addition a number of smaller groups have met at the Station in New Haven, or at one of the Station farms. The usual field day at the Tobacco Substation was omitted this year.

Changes in Staff

Appointments

Mrs. Oran B. Stanley, A.B., Secretary in Soils Department, October 28, 1932.
Miss Genevieve Booth, A.B., Secretary in Plant Breeding Department, December 1, 1932.
Miss Helen A. Hulse, Secretary in Entomology Department, July 1, 1933.

Resignations

Mrs. Catherine R. Miller, M.A., Secretary in Plant Breeding Department, December 1, 1932.
Mrs. Gladys Brooke, B.A., Secretary in Entomology Department, August 1, 1933.

Projects for 1933–34

Analytical Chemistry

1. Inspection of fertilizers.
2. Inspection of feeding stuffs.
3. Inspection of foods and drugs.
4. Calibration of Babcock glassware and thermometers
5. Analyses of insecticides and fungicides.
7. Analyses of special and miscellaneous foods.
8. Collaborative studies on analytical methods.

Biochemistry

1. Cell chemistry.
   a. A detailed examination of the nitrogenous constituents of plant cells, in particular those of leaf tissues. The further development of methods for the determination of the different forms of nitrogen in extracts of such tissues.
   b. An investigation of the constituents of the tobacco plant with special reference to the changes that occur during curing.
   c. An investigation of the composition of tobacco seed.
2. Protein chemistry.
   a. The methods for the determination of the basic amino acids yielded by proteins with the object of increasing their accuracy and convenience.
   b. The methods for the separation of other amino acids yielded by proteins.
   c. The properties of certain of the amino acids and their derivatives.
   d. Methods for the preparation of pure proteins on a large scale with the object of obtaining material for chemical and nutritional study.
3. Nutrition investigations.
   a. The relation of diet to the rate of growth with special attention to certain factors that appear to determine rapid growth.
   b. The investigation of the relation of certain constituents of the diet to the growth of skeletal tissue.
   c. The relation of rate of growth to well-being as shown by the investigation of certain organs and tissues.
   d. The relation of the rate at which growth has occurred to the basal metabolism of the rat.
   e. An investigation of the requirements of mineral nutrients.

Botany

2. The nature and cause of mosaic diseases of plants.
5. Plant disease survey of Connecticut.
8. Spraying and dusting experiments on apples and peaches. (See also Entomology, No. 3.)
15. A study of the virulence of the chestnut blight.
20. Diseases of shade trees.
24. Studies of the morphology of the willow scab fungus.
27. An investigation of an elm disease in Connecticut.
28. Studies on the identification of apple varieties by seed characters.
29. The absorption of nitrogen through the leaves of the plant.
30. Investigations on the diseases of vegetable crops and their control
31. Investigation of a new peach "trouble."

Control and Service

12. Seed testing.
25. Spray service (with the Extension Service.)

Entomology

Spraying and dusting experiments on apples and peaches. (See also Botany, No. 8.)
9. Insect survey of Connecticut.
17. Studies in the control of the Oriental fruit moth.
21. Control of the spinach leaf miner.
28. Investigations on oil sprays.
29. Control of the Mexican bean beetle in Connecticut.
30. A study of insects that attack the tobacco plant. (See also Tobacco Substation, No. 20.)

Studies on the biology and control of the European pine shoot moth. (See also Forestry, No. 13.)
32. The biology and control of the potato flea beetle.
33. Mosquito control.
34. Clothes moths.
35. The biology and control of the white apple leafhopper.
36. The control of onion thrips.
37. Substitutes for Lead Arsenate in orchard sprays.

Control and Service

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

Forestry

Experimental plantations on a sandy tract at Rainbow.
a. Comparison of many species of conifers and hardwoods, in pure stands and in combinations.
b. Methods of management for those species that have survived.
c. Studies on growth and habits of the several species.

2. Effect of thinning in white pine at Shaker Station.
3. Effect of thinning in hardwoods at Quassipaug Lake.
6. Studies of forest plantations throughout the state.
   a. Comparative growth of various species.
   b. Reasons for success or failure.
   c. Soil and other site factors necessary for success of each species.
10. An investigation of the distribution and growth of forest trees as influenced by soil conditions and other site factors.
11. Coniferous seed bed study to determine:
   a. The value of fertilizers in seed beds.
   b. The value of different amounts of seed.
   c. The value of dusts and sprays in preventing dampening off.
12. A study of preservative treatments of native woods used for posts.
13. Studies on the biology and control of the European pine shoot moth. (See also Entomology, No. 31.)

Control and Service

5. Distribution of forest planting stock. (Under Clarke-McNary Act.)
7. Control of white pine blister rust. (With U. S. Dept. Agr.)

Genetics (Plant Breeding)

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

Soils

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

Tobacco Substation

1. Fertilizer experiments—various sources and rates of nitrogen, phosphoric acid, potash, lime and magnesia.
2. Field tests with farm and "commercial" manures.
4. Tobacco nutrition studies—the role of nitrogen, sulfur, potassium, calcium, manganese, boron and magnesium.
5. Improvement of Havana seed tobacco. (With U. S. Dept. Agr.)
6. Improvement of Broadleaf tobacco.
7. Improvement of Cuban shade tobacco.
8. The effect of various winter cover crops used on tobacco land.
11. Soil reaction in relation to tobacco.
13. Preservative treatment of shade tent poles. (See Forestry, No. 12.)
17. The role of humidity and temperature in curing tobacco.
19. Diseases of tobacco—a Pythium damping-off and root-rot.
20. A study of insects that attack the tobacco plant. (See also Entomology, No. 30.)
23. Studies on the rate of growth of tobacco.

Publications

Bulletins of the Station

REPORT ON COMMERCIAL FERTILIZERS FOR 1932. E. M. Bailey. No. 343.

PLANT PEST HANDBOOK FOR CONNECTICUT, I, Insects. W. E. Britton. No. 344.

DEDICATION OF JENKINS LABORATORY, October 11, 1932. No. 345.

THE COMPOSITION OF SOME COMMERCIAL INSECTICIDES, FUNGICIDES, BACTERICIDES, RODENTICIDES, AND WEED KILLERS, A COMPILATION. Supplement to Bulletin 300. H. J. Fisher and E. M. Bailey. No. 346.

REPORT OF THE DIRECTOR. William L. Slate. No. 347.

THE BIRCH LEAF-MINING SAWFLY. Roger B. Friend. No. 348.

CONNECTICUT STATE ENTOMOLOGIST, THIRTY-SECOND REPORT, 1932. W. E. Britton. No. 349.

TOBACCO SUBSTATION AT WINDSOR, REPORT FOR 1932. T. R. Swanback, O. E. Street, and P. J. Anderson. No. 350.

REPORT ON COMMERCIAL FEEDING STUFFS FOR 1932. E. M. Bailey. No. 351

CHEMICAL INVESTIGATIONS OF THE TOBACCO PLANT. Part IV. Hubert Bradford Vickery and George W. Pucher. No. 352.

STUDIES ON PARASITES OF THE ORIENTAL FRUIT MOTH, I, Trichogramma. Philip Garman. No. 353.

REPORT ON FOOD AND DRUG PRODUCTS FOR 1932. E. M. Bailey. No. 354

Circulars of the Station

Testing Vegetables for Connecticut, Results for 1932. Lawrence C. Curtis. No. 87.

Control of the Mexican Bean Beetle. Neely Turner and Roger B. Friend. No. 88.

Soil Testing Service. M. F. Morgan. No. 89.

The European Pine Shoot Moth. Roger B. Friend and H. W. Hicock. No. 90.

Unemployment Gardens. Joint Bulletin with the Connecticut State College. No. 91.

Control of the European Corn Borer. M. P. Zappe. No. 92.

Insects that Injure Cucumber, Melon, Pumpkin, and Squash Plants in Connecticut. W. E. Britton. No. 93.

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BENEDICT, FRANCIS G., HORST, KATHRYN, and MENDEL, LAFAYETTE B. The heat production of unusually large rats during prolonged fasting. Jour. Nutr., **5**: 581–597. 1932.

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FRIEND, R. B., and WEST, A. S. JR. The European pine shoot moth, *Rhyacionia buoliana* Schiff., with special reference to its occurrence in the Eli Whitney forest. Yale Univ. School of Forestry, Bul. **37**: 65. 1933.

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All of which is respectfully submitted,

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Director