FALL ISSUE NOVEMBER 1955

FRONTIERS of Plant Science

Henry C. deRoo, soil scientist at the Tobacco Laboratory in Windsor, takes a tobacco plant root sample. The 6-inch monolith of soil, 2 feet deep, is removed without root displacement. Needles hold the roots in position when the soil is soaked and washed away in a tank filled with water. For a closer look at roots under different conditions, see page 4.

The CONNECTICUT AGRICULTURAL EXPERIMENT STATION · New Haven

Osborne Library Dedicated

E. V. McCollum Reviews the Contributions Made Here by Thomas B. Osborne, World-Renowned Biochemist

Following is a digest of the address of E. V. McCollum, professor emeritus of the Johns Hopkins University, at the Osborne Library dedication, September 28

MY MEMORY of Dr. Thomas B. Osborne pictures him as an unassuming, thoughtful man, who devoted his attention to the study of proteins with an unsurpassed singleness of purpose and sustained enthusiasm, year after year.

There are several remarkable elements in his scientific career which, I believe, are not yet sufficiently appreciated. First among these was his courage in undertaking what to many seemed a hopeless enterprise.

In order to comprehend fully what he did, one must be acquainted with the small rewards of perhaps a dozen of the most devoted chemists who, throughout more than a hundred years, had sought to learn something about the chemical nature of what were generally designated the albuminous substances.

Where so many had failed of accomplishing their objectives, the prospect of succeeding seemed so remote as to make protein investigation appear to nearly all chemists as unrewarding.

Yet in 1888, Osborne set himself to study intensively the problem of the number and nature of proteins in the vegetable kingdom. In this undertaking he was eminently successful. He surpassed his predecessors by far in gaining exact and comprehensive knowledge where before all was confusion.

Perhaps even more to be wondered at was that a program of protein studies in 1888 should have been initiated at an agricultural experiment station.

Wanted Practical Results

Historical accounts of the early stations afford many evidences of skepticism among farmers and lawmakers. From the experiment stations they wanted immediate and practical results; in short, service. In general, station directors exercised caution about incurring criticism for spending public funds on projects which laid them open to attack by politicians.

Yet it was under just such conditions that Director Samuel W. Johnson suggested to young Thomas Osborne that he devote his attention to a long-term program of fundamental research. It held little promise of having any future value to farmers.

Toward the end of the 19th century Osborne, having during the preceding decade isolated, purified, and described several proteins from the seeds of each of 32 plants, turned his attention to their chemical analysis.

Thomas B. Osborne, 1859-1929. He studied the proteins with "sustained enthusiasm."

His investigations in this field far surpassed in number and accuracy those of his contemporaries.

The idea that the proteins must have different nutritive values—an idea based on the strongly contrasting yields of amino acids—remained to be verified. Dr. Osborne undertook to establish this principle in a third phase of his investigation of proteins.

Added New Chapter

In collaboration with his distinguished colleague, Dr. Lafayette B. Mendel, these investigations soon added a new chapter to the knowledge of the protein element in nutrition.

By their experiments, continued for more than a decade, they surpassed all previous achievements in dramatizing the importance of individual amino acids in nutrition.

Thomas B. Osborne was a man with a strong sense of purpose, who realized the long-term value in the search for understanding of the phenomena of biology. He was infatuated with his investigations. His work never ceased to have the spirit of intellectual adventure.

His years were devoted to a worthy cause.

There could be no more fitting tribute to the man we honor, than to commemorate his name by calling this repository of great thoughts and discoveries the Thomas B. Osborne Library.

The interior of the library building, a chemical laboratory from 1882 to 1910, was completely remodeled in 1955. Dr. Osborne worked for 16 years in the upper floor laboratory. Here is housed his scientific library, given to the Station in 1928.

The Mystery of the Missing Mercury

by A. E. Dimond . . . *Department of Plant Pathology and Botany*

ONE OF THE exciting things about working at The Connecticut Agricultural Experiment Station is that you never know what's going to happen next, but you can be sure that whatever happens, it will be interesting. Let's take, as an example, the story behind Bulletin 595. This bulletin bears the title "Toxicity to Greenhouse Roses from Paints Containing Mercury Fungicides."

The story begins for us with a call for help from a commercial rose grower who had applied a white paint to the sashbars of his greenhouse. A little while later, some of his roses began to turn purple, the buds became brown, and flower production almost stopped. The grower suspected mercury injury to his roses because the paint contained an organic mercury compound to prevent the paint from mildewing. He brought the problem to The Connecticut Agricultural Experiment Station. The roses showing injury were already a loss and he proposed to replace them with new ones. But how could he avoid injury to the new plants?

Find Cause of Injury

First we got samples of rose leaves and flowers that showed the injury and some that were growing in the next house in healthy condition. Chemical analyses showed the injured plants contained more mercury than healthy ones. Also the injured plants showed the same symptoms as those described for mercury injury to roses some years earlier by two researchers at the Boyce Thompson Institute.

Evidently some form of vapor containing mercury was being released slowly from the paint film. Chemical tests showed that the rose plants accumulated enough mercury to cause injury, although the amount of mercury in the greenhouse air was almost immeasureably small.

Next we had to learn in what chemical form the mercury was vaporizing from the paint film. This was a necessary step because how you prevent the release of mercury depends upon the kind of mercury compound that the film was releasing. By suitable chemical and physical tests, it was shown that metallic mercury vapor was involved. In other words the organic mercury compound that was added to the paint somehow was broken down to elemental mercury in the dried paint film and then it was released.

Solvents Hasten Breakdown

Now the organic mercury compound that was added to the paint does not break down to mercury very rapidly when in pure form. But we soon found that quite a number of the oils and solvents in paint hasten the breakdown of the organic mercury compound to mercury. Because mercury vaporizes much more readily than the organic mercury compound, it is easy to see why breakdown of the organic compound resulted in more ready release of mercury vapor. Our studies showed that the mercury will continue to escape from the paint film over a period of many weeks. This means that any greenhouse where such paint has been applied may not be useful for growing plants susceptible to mercury for quite a long time unless some corrective treatment is applied.

While these studies were going on, the rose grower was moving forward. New plants were ordered, the old greenhouse benches were emptied of soil and both benches and soil were replaced. We now knew that we must have some kind of answer for him by the time he was ready to plant the newly ordered roses. And time was getting short.

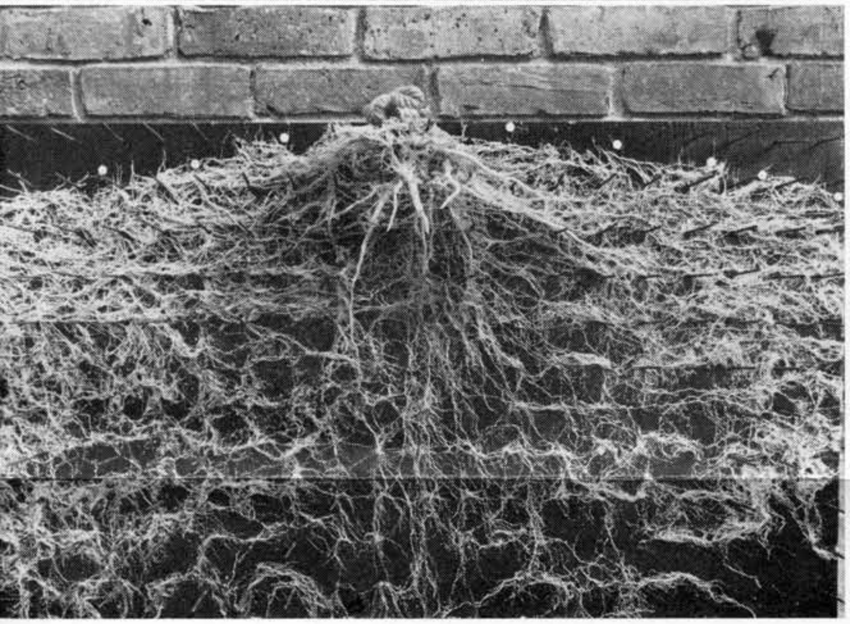
Before we could take the next step we had to have an accurate method of measuring the rate at which mercury vapor was released from paint films, so that we could compare the value of one corrective treatment with another. Luck was with us, and we located in the Bureau of Industrial Hygiene of the State Department of Health, an instrument that is used constantly for measuring concentrations of mercury vapor in industrial plants to safeguard the health of workers. This instrument was quickly made available to us for the present study.

With this instrument, we could move fast. Many kinds of paint were applied over the mercury-containing paint, but none of them sealed the mercury in. In fact some of them caused mercury to be released even more rapidly than before, because they contained materials that even further accelerated the breakdown of the organic mercury compound.

Lime Sulfur Traps Mercury

Then we had an idea. Lime sulfur, a fungicide used for many years, slowly gives off hydrogen sulfide. Perhaps the mercury vapor would be trapped as mercuric sulfide, a very stable compound, if it had to pass through a coating containing lime sulfur. But how to apply the lime sulfur? If it was just sprayed on, the spray would not form an even coating over the paint film but would be distributed in droplets. To overcome this difficulty, we mixed the lime sulfur with wheat flour and water to make a paste that could be applied with a brush to the surfaces coated with the mercury-containing paint. When this coating was applied over the mercury-containing paint, *practically no mercury vapor escaped.* The idea worked. That same day the rose grower called, said he was ready to plant and wanted to know if we had the answer. We said we thought so, and he applied the treatment at once. A single treatment did the job and the roses in this house are now flourishing.

Mercury injury to susceptible varieties of roses causes off-color flowers; symptoms may persist months after exposure.



Top photo shows an experimental method of loosening the compaction pan and deeper subsoil. Topsoil was replaced and regular field treatment given the Havana Seed tobacco seedlings. Below, the root system of a plant grown on such a loosened soil. Deep and well developed system penetrated the soil readily.

Soil type involved in this study is Merrimac sandy loam

LET'S LOOK AT TH

FARMERS AND gardeners, even though wise in the ways of plants, may sometimes forget that frequently about half of a plant lives below the surface of the soil. Most crops are commonly evaluated by the parts above ground. Beets, carrots, chicory, and turnips are among the few crops grown primarily for their roots.

In spite of this failure to appreciate the importance of the plant roots, most of our efforts to promote growth are directed to the below-ground parts. Exceptions, of course, are plant breeding and control of plant pests and weeds.

Fertilization, irrigation, and most other cultural practices affect the roots of the plants first.

Samuel W. Johnson, distinguished director of this Station, said in 1872: "It is greatly to be desired that our knowledge of the relative development of the roots of our various crops should be completed." Much has been learned, but we still know too little about the growth habits and functions of roots. The field remains a frontier of plant science.

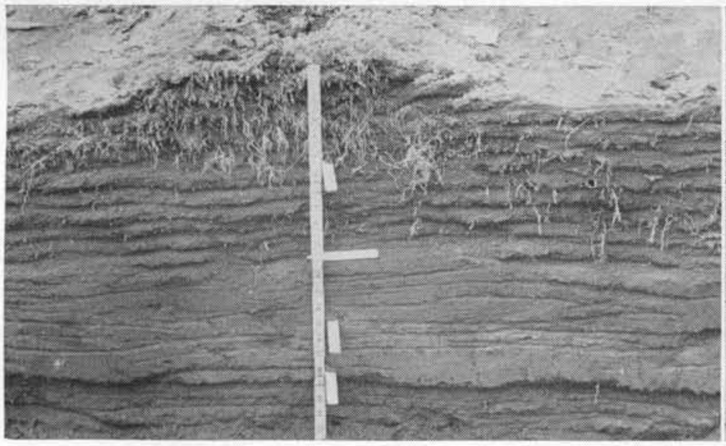
It is well known that each plant species has a more or less characteristic root system which, however, can be modified by soil conditions. In most species, as shown by J. E. Weaver of the University of Nebraska, there is also a rather definite relation between root and top growth. A vigorous plant above ground depends upon a well developed and healthy root system.

The volume of soil suitable for root development is an important factor in soil productivity. Increasing the root zone is the most effective way, in many soils, for enlarging water storage capacity and for making more plant food available for crop growth.

An ideal soil is deep and well structured, with plenty of room for the root system of the plant to grow and develop.

Root room may be restricted by solid bedrock at a shallow depth, by a high water table which results in lack of oxygen, by compaction pans which interfere with aeration and resist root penetration, and by poor structure which affects pore size distribution. Excess salts and extremes of alkalinity or acidity may also limit or prevent root growth.

Drainage, shattering of the compaction pans, and practices



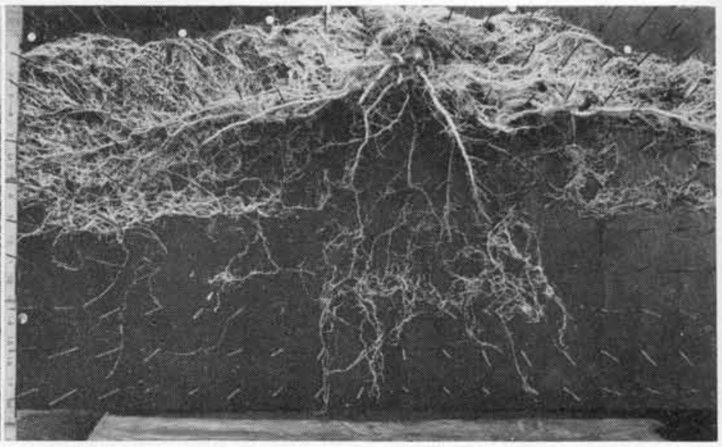


Photo at left shows the wall of a pit dug across a row, 3 inches from the stem of a havested Havana Seed tobacco plant. The profile shows compactness and root development in the different soil horizons. Massive portion of the root system is in top 6 inches of the hilled and cultivated part of the plow layer. Only one root showed in the hardpan (11 to 18 inches). Needle-board profile at right shows root system in a 6-inch slice from the same profile. Most roots are in top 6 inches; root growth in lower part of plow layer was inhibited by repacked soil condition. Few roots extend below plow depth.

ROOTS

by Henry C. deRoo . . . *Tobacco Laboratory, Windsor*

designed to improve soil structure are some of the means to make possible better root growth. Excessive concentrations of salts may be removed, and lime or plant foods, or both, added to the soil below plow depth.

Traffic Speeds Compaction

Physical soil condition now seems to be an obstacle on many soils where drainage, irrigation, better varieties, and adequate fertilization and pest control are the rule. Farmers and research workers find evidence that the problem becomes more serious as tractor and implement traffic increases on cultivated land. In brief, the mechanized farmer seems to be tilling the surface and packing the plow-depth layer, thereby rather permanently affecting soil structure.

At this Station we are experimenting with various crop rotations, soil treatments, and implements to learn more about this problem.

We find, so far, that deep tillage, reduction of machine traffic, and plowing under special rotation and cover crops—mostly grasses or legumes—generally overcomes the traffic and tillage pans and avoids excessive surface-soil pulverization by intensive cultivation.

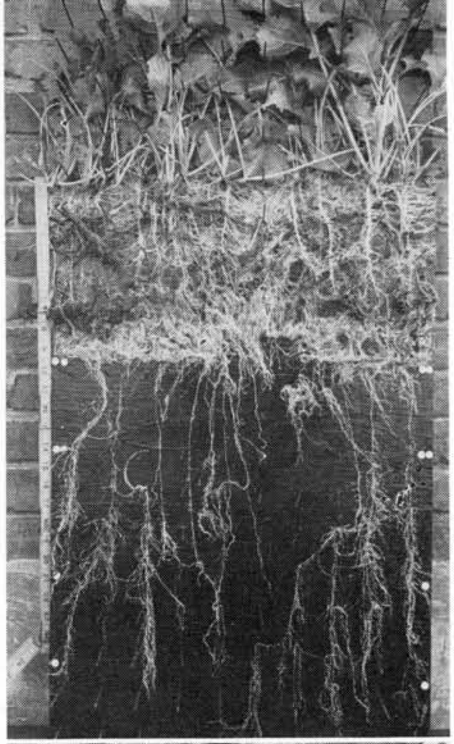
More recently we have made careful studies of the relationship between soil conditions and root growth, especially of tobacco and its cover crops. These studies begin with examination of the root pattern, using the device shown in the cover photograph. We must then try to interpret the differences we find, with careful attention to the soil profile, especially its physical resistance and aeration.

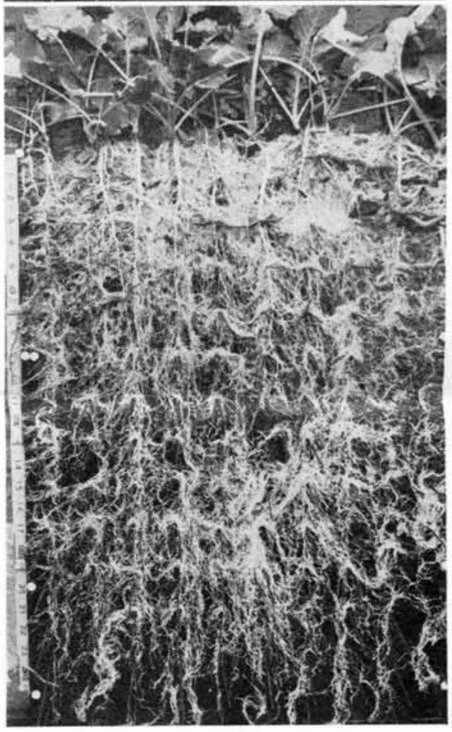
Core sampling helps us to measure some of the properties of soils, the eye and the hand make possible more rapid evaluations.

Root Study Needed

A root study, however, is often needed to show soil disturbances otherwise almost undetectable. Different methods of deep tillage and management are measured first by root penetration and distribution. More conventional measures of performance, such as yield and physical soil properties, are also used extensively. But the direct response of plants to such practices is best shown by their root systems.

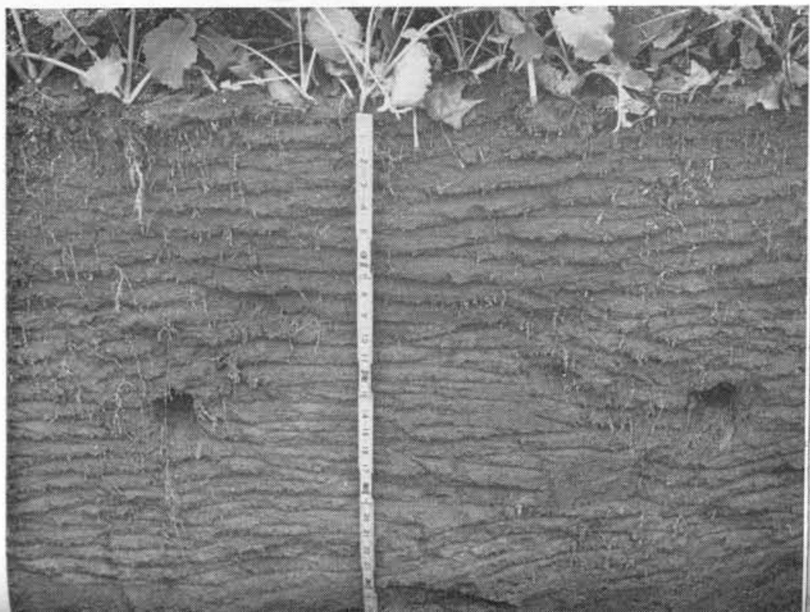
Better knowledge of the development and distribution of roots, as Director Johnson said so long ago, is greatly to be desired. With this knowledge we can move toward more effective use of our soils. Without this knowledge we are handicapped in research on the effectiveness of tillage, fertilization, irrigation, and other cultural practices on crop production.

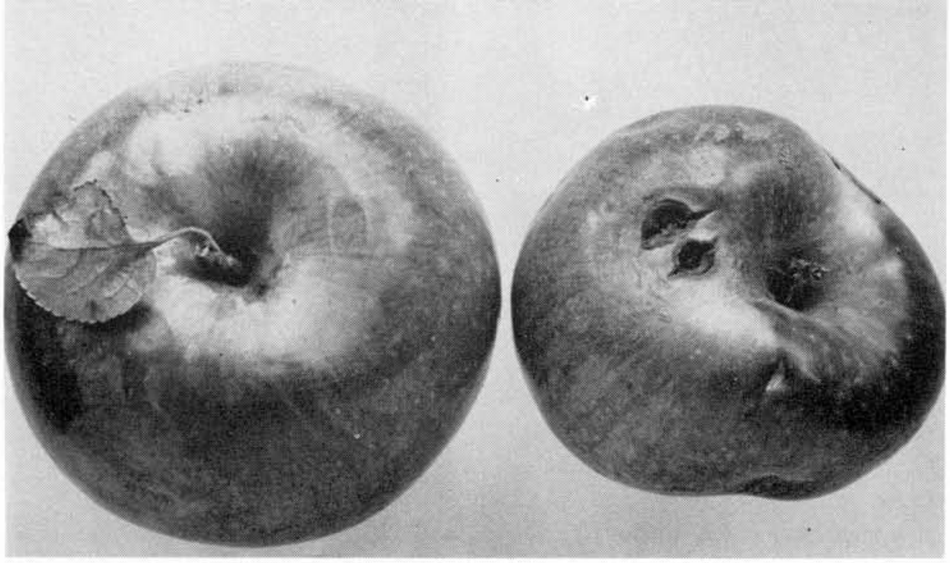




At top, root systems of rape plants restricted by compacted layer at plow depth. Lower photo shows uninhibited root growth in soil loosened by hand with a fork.

At left, profile of a tobacco soil loosened with a chisel-type subsoiler in early fall, then seeded with a Dwarf Rape cover crop. Grooves of the subsoiler are 2 feet apart at a depth of 16 inches. Root pattern in late fall, at right, shows how fibrous roots have penetrated the mechanically cracked hardpan, stabilizing the fractured condition and adding organic matter in deeper soil layers. Unbroken block of soil between grooves stopped root penetration. Needles in the board are 2 inches apart.





Pest control improves both quantity and quality of apples. A sprayed apple on the left, the *best* unsprayed apple on the right.

Safeguarding Our Food Supply

Recent Legislation Seeks to Insure Abundant Supply of Uncontaminated and Wholesome Food

by Neely Turner . . . *Department of Entomology*

THE USE OF pesticides to protect crops from destruction by insects and diseases has become standard practice all over the world. The resulting increased production of crops has been enormous. At the same time, it has been recognized generally that residues of dangerous chemicals on food crops must be avoided. In this country, this recognition followed the most natural course of Federal regulation of pesticide residues. The most recent legislation, Public Law 518, has just become effective. As is usually the case, this legislation has produced some misunderstanding and a little confusion. This bill can be understood best by reviewing the problem and discussing briefly all the legislation regulating sale and use of these essential chemicals.

Modern Science Curbs Losses

Insects and diseases have ravaged crops from the days of the earliest recorded history to the present. The resulting loss of food crops has in the past caused famines and mass migrations of large numbers of people. In recent years such catastrophies seldom occur, thanks to development of methods of forecasting outbreaks and to availability of chemicals to control insects and diseases.

These chemicals are of comparatively recent origin. The first successful insecticide was Paris Green, used by some unknown farmer about 100 years ago to control the Colorado potato beetle. Millardet developed the first successful fungicide about 70 years ago, following his observation that grapes daubed with copper sulfate and lime to prevent thievery did not rot. Until 1930 development of other chemicals followed relatively slowly, but even so there was almost constant progress in reducing the damage done by pests.

Helps Keep Costs Down

During the last decade development of pesticides has been very rapid. Most of the materials used in 1955 were either unknown or in test tubes in 1945. Many of the pests controlled so well today were accepted as part of the hazard of food production in 1946. The economical control of pests must get much of the credit for the ability of American farmers to produce food at 1945 prices in the face of sharp advances in the cost of other basic commodities.

It is obvious, then, that use of pesticides is an integral part of agriculture. It is also obvious that some consideration must be given to effects other than on insects of chemicals so widely used.

The first legislation on pesticides, passed almost 50 years ago, dealt with labelling. The regulations were designed to insure that the materials were "up to standard," and that no ingredients injurious to plants had been added. This legislation has been amended from time to time, and the present very comprehensive regulations require (1) evidence that control of pests is required to protect the crop, and (2) that the pesticide will control the pest when used as the label directs.

The first legislation on pesticide residues was passed almost 30 years ago. This too has been amended, the most recent addition being Public Law 518. The present laws require substantial evidence of (1) the degree of toxicity of the pesticide to mammals, and (2) the safety of residues when the material has been used according to the directions on the labels.

Data Summarized on Label

The acceptance of labels and the establishment of tolerances assure farmers that these materials have controlled pests and that the residues are not excessive. At the same time, consumers are assured that use of the materials is necessary and that the food produced by their use is safe for consumption. The labels on packages of pesticides are, therefore, important sources of scientific information. They are really a concise summary of the facts formerly contained only in experiment station and extension bulletins and circulars.

The principal new provisions of Public Law 518 were (1) the setting of a definite time when materials now available would be either accepted or rejected, and (2) procedures for future action on materials and for adjudication of differences of opinion.

A careful comparison of pest control methods developed by The Connecticut Agricultural Experiment Station and the regulations issued shows that most of the materials and methods meet fully all legal requirements. Only those control measures still in the process of development, such as for control of forage pests, are in any doubt. The status of these undoubtedly will be settled long before the 1956 growing season.

No Compromises

Finally, it must be emphasized especially for the consumer that the residue requirements set by the regulations are not compromises. They are the result of thorough study by toxicologists and chemists, and have been based on the findings. The basic purpose of the legislation, to insure an abundant supply of wholesome and uncontaminated food, has obviously been given first consideration at all times.

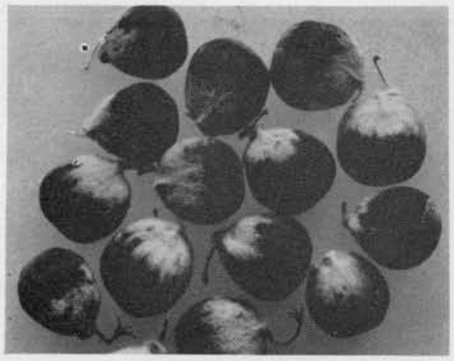
CHESTNUT BREEDING a progress report

by Arthur H. Graves . . . *Department of Genetics*

SINCE THE early part of the present century, in the time of Dr. G. P. Clinton, Botanist, and Walter O. Filley, Forester, The Connecticut Agricultural Experiment Station has been interested in the chestnut. And rightly so, since chestnut formerly composed a large percentage of Connecticut's forest. The tall, straight, fast-growing trees were ideal for telephone and telegraph poles which, being remarkably decay-resistant, stood up firmly in time of flood and storm. A recent bulletin of the Southern New England Telephone Co. states that even today 11,000 native chestnut poles as well as 25,000 poles of southern chestnut are still in use.

Blight Is No Mystery

There is nothing mysterious about the chestnut blight, as some people seem to think. It would be better to call it the chestnut bark disease, for it is usually limited to the bark, and possibly one or two adjacent layers of wood. The fungus parasite, which entered this country probably in the 1890's, on imported oriental chestnuts, found a new, untried victim in the American chestnut. Having gained a foothold, the parasite's remarkably professional methods of attack and spore dissemination brought about what now seems to be the practical extinction of the American chestnut as a forest tree. The fungus, which can be carried long or short distances on the feet of birds, and short distances by insects, enters the tree through old branch stubs or wounds in the bark, or can be carried into the bark by boring insects.



Nuts of the American chestnut sent to the Station this fall by L. J. Kilby of Sperryville, Virginia. The very woolly lower third is a variation. (About ½ natural size.)

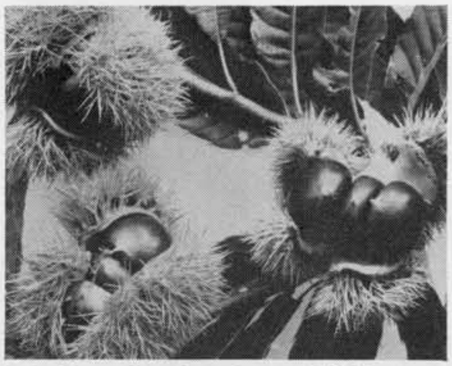
Early in the history of this disease it was definitely determined that the Japanese and Chinese chestnuts are more or less resistant to the attacks of the parasite. So, after repeated attempts to control the disease, the only practicable way to regain a chestnut tree of timber type was to breed the American species with the orientals. Since the latter were comparatively low-growing, branchy trees although blight-resistant, and the American chestnut, tall, straight, and blight-susceptible, according to the Mendelian law some of the hybrids should be tall and blight-resistant. Our first crosses of Japanese and American chestnuts proved this to be the true but not exactly as we had expected. The hybrids showed rapid, erect growth but were not quite as resistant as the Japanese species. Therefore, we crossed these again with the Chinese species with the result that we now have hybrids which are both tall and blight-resistant. Therefore, the question that many people are asking "Have you really got a blight-resistant timber chestnut?" can be definitely answered in the affirmative.

Lack Delicious Sweet Flavor

The nuts of these Chinese X Japanese-American hybrids are invariably large (photo at left) and do not have the delicious sweet flavor of the native American chestnuts, but, on the other hand, they are packed full of calorie-rich starch and are ideal for stuffing the Thanksgiving turkey.

Hybrids of Chinese and American chestnuts also show great promise. Several of these are now growing in the Litchfield Plantation on the grounds of the White Memorial Foundation. The U. S. Department of Agriculture, which has carried on breeding work with the chestnut, and has cooperated closely with us, has also developed blight-resistant Chinese-American hybrid chestnuts.

One hurdle we have yet to take successfully, namely, that of vegetative reproduction. It is impossible to reproduce our elite hybrids by planting their nuts because the chestnut is *self-sterile*. Any nut of a chestnut tree is (with rare exceptions) the result of a cross with *another* chestnut



Fruit of one of our best chestnut hybrids, a cross of Japanese and American, crossed again with Chinese chestnut, as grown at the Sleeping Giant Plantation in Hamden. (About ¼ natural size.)

tree. The situation is similar to that of apples, pears, and other fruits which do not grow "true to seed." Hence, our fruit trees are commonly *grafted* on some other stock. For the present, until we obtain success in rooting cuttings or in "air layering," we must use the same method of propagation for our elite chestnuts and for this, arrangements are now under way with some local nurseries. The U. S. Department of Agriculture and The Connecticut Agricultural Experiment Station do not have the facilities for distribution of plants to the general public.

At the present time the Station has several thousand chestnut trees of all stages from one to twenty-five years of age. These are located at the Sleeping Giant Plantation, the Station farm in Mt. Carmel, the Litchfield Plantation of the White Memorial Foundation, on land of Archer Huntington at Redding Ridge, Conn., and in more than a dozen small test plots in the eastern United States.

Essate-Japanese chestnut, a tree highly resistant to blight, with rather small nuts of good flavor.

From the Director

THREE YEARS ago this month, we mentioned in this column the dire need for a new research laboratory at the Experiment Station. This month, we wish to express the thanks of the entire staff to the General Assembly which voted the funds, and to the citizens of Connecticut who responded to the call from the Legislature, "Is this building needed?"

We on the staff were profoundly impressed by the wide variety of persons who advised the Legislature on how they used the results of the Station's research and why the laboratory is important.

Thus spoke those who grow the food we all eat, tomatoes for the soup; silage and corn to produce milk and the meat for the main course, butter for the bread, and cream for the coffee, the side dishes of potatoes and vegetables, fruits for the salads, honey for the sweet tooth, and the after dinner cigar; and thus also spoke those who grow our seeds; and those who grow trees in the forests for lumber, or on the streets and lawns for shade; those both amateur and professional who grow flowers, grass, and shrubs for beautification; those who control insects in public buildings; and those who are concerned with clean waters.

Thus were represented the cemetery operators, conservationists, exterminators, farmers of all types, florists, foresters, garden clubs, golf course operators, nurserymen, plain citizens, seedsmen, and tree experts.

We promise you all that we will do all we can in our new laboratory to advance the "Frontiers of Plant Science" so that we may find the solutions for tough problems still unsolved and that more food may be produced for the rising generations.

James G. Horsfall

New Publications

Copies of publications listed below are free to residents of Connecticut who apply for them, and to others as editions permit. Address requests to Publications, The Connecticut Agricultural Experiment Station, Box 1106, New Haven 4, Connecticut.

Insect Pests of Ornamentals

B 591 Mite Pests of Ornamentals and Their Control

C 194 Control of the Andromeda Lace Bug

Insect Pests of Vegetables

B 590 Dust Insecticides for the Control of the Imported Cabbage Worm

C 193 Control of DDT-Resistant Potato Flea Beetles

Insecticides and Fungicides

B 594 Tests for Type of Action of Hydrocarbon Insecticides Applied Jointly

B 595 Toxicity to Greenhouse Roses From Paints Containing Mercury Fungicides

Lawns and Turf

C 195 Ground Moles and Their Control

Soils and Soil Fertility

B 593 The Use of Woodchips and Other Wood Fragments As Soil Amendments

Tobacco

C 191 Control of Some Tobacco Pests

Other Subjects

C 192 Blight-Resistant Chestnuts — Culture and Care

Report on Inspections

B 592 Commercial Feeding Stuffs, 1953 Report

Persons interested in bulletins and circulars of this Station are invited to request a List of Available Publications. Professional workers in the fields of plant science and inspection, and librarians, may obtain copies of some publications not included in the current list. Specific requests will be filled as supplies permit.

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