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FRONTIERS of Plant Science

FALL ISSUE

In an experimental shade tent, Plant Pathologist Saul Rich tries out new fungicides for control of blue mold on tobacco. This is just one approach the Experiment Station is trying to find better and cheaper controls for this serious disease of the Connecticut Valley crop. See story on pages 4 and 5.

THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION, NEW HAV

The Right Spray Gives A Better-Flavored Apple

by Philip Garman[1]

What kind of an apple is a good apple? If asked, Mrs. Housewife would undoubtedly mention a list of characteristics that would go something like this: high color, clear skin, sweetness, flavor, and good eating and cooking quality.

To combine all of these characteristics in a single fruit is a difficult job and many factors enter into it. Fertilizers, individual varieties or strains, the soil and climate where the fruit is grown, and the condition of the tree itself all play a part. Now the fruit grower is beginning to realize that still another factor must be considered in his efforts to obtain top quality.

Sprays Affect in Several Ways

Experiments at the Connecticut Station over the past several years have shown quite definitely that the sprays put on to control insects and diseases can influence the quality of apples in a number of ways. Insecticides and fungicides, we have found, can affect the metabolism of the tree and, hence, the quality of the fruit. For example, acids, sugars and mineral content may be increased by some sprays and decreased by others. Sugars and acids are the main components of the apple that affect flavor and, in general, the public prefers apples with a high sugar and acid content.

It is apparent also from our work so far that a number of pesticides reduce productivity and keep trees from bearing to full capacity. Other sprays may damage the surface appearance of the fruit. Sprays that cause roughened skin often also produce an inferior apple from the flavor standpoint, since a blemished outer surface is frequently a sign that there have been other, less apparent injuries to the tree or leaves. At least one of the sprays which produced russetting of the skin in a series of tests, also caused a marked decline in acid content of the fruit, and tended to reduce yields the following year. Obviously, sprays of this kind should be used only with considerable caution and limited to the least possible number of applications. In many cases, less injurious sprays may be substituted.

Combinations Complicate

While our work is now far enough along that we can fairly well determine what specific spray materials to avoid in the orchard, the problem is complicated by the fact that combinations of sprays easily alter the picture. Chemicals that appear to be good when used individually may react with one another to produce undesirable results. For example, lead arsenate in combination with sulfur has usually produced inferior-tasting apples. If thiram or captan is substituted for sulfur and combined with lead arsenate, the flavor improves. On the other hand, substitution of methoxychlor or TDE for lead arsenate, while in general producing an apple of more pleasing appearance, has not given the desired flavor improvement with all varieties.

The problem of rating flavor has been the most difficult technique to master in judging the results of the experiments. Surface damage and chemical content of the fruit can be measured with scientific accuracy, but flavor testing brings in the human element. Taste panels are never in 100 per cent agreement because of individual preferences, as well as other less tangible influences. Thus, a 3 or 4 to 1 preference may be considered very good and a 2 to 1 or 1.5 to 1 only suspicious. The human taste is so constituted that apples sprayed with one material may be preferred on Monday and those treated with a completely different pesticide may be the favorites on Tuesday. To iron out some of these inconsistencies, a cooperative regional project has recently been organized among experiment stations from Maine to Maryland. The project will work towards setting up standards and putting methods of quality determination on a sounder basis.

Sprays can cause damage to the outer appearance of apples. This one shows sun scald, caused by sulfur sprays.

The outside appearance of the apple has been mentioned as influencing acceptance of apples by the housewife. Normally, commercial grades are based on size, finish and color. However, it is not at all certain that the apples meeting the commercial grades are always of the best quality as regards flavor. A taste test conducted with graded fruit at one of the annual fruit growers conventions showed rather distinct flavor preferences for apples not meeting the commercial grades. While it was not possible to track down all the spray programs involved, enough was learned to realize that some of the spray programs were identical with those causing difficulty in our experimental work.

In this short article, it is impossible to mention all of the specific spray materials which influence quality, either favorably or unfavorably. We know, for example, that glyodin increases sugar content and that captan builds up the amount of acid in the apple. Other sprays, such as dichlone, show a strong tendency to reduce acids. Minerals may be reduced by the use of lead arsenate. Our taste panels have shown a significant preference for fruit sprayed with thiram as compared with sulfur, and in some cases for apples treated with the fungicides, glyodin and captan, and certain nonarsenical insecticides. The subject is covered more fully in Station Bulletin 576, "Quality of Apples As Affected by Sprays," which is available to any fruit grower who requests it.

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[1] Dr. Garman is an entomologist whose special field is fruit insects.

Plant Disease Controlled by Radiation

by Paul E. Waggoner[1]

We hear a lot these days about harnessing atomic power and putting it to work at our everyday tasks. Plant scientists have long been interested in the peacetime uses of atomic energy, and have already found several applications. Perhaps the best known is the use of radioactive isotopes as "tracers". By irradiating or "tagging" an element, the scientist can easily trace its progress through a plant with a Geiger counter. The technique is a tremendous time-saver. For example, with "tracers", it is quick and easy to find out how a plant is utilizing the fertilizer put on to encourage its growth.

Still newer than "tracers" is the use of atomic energy to control plant diseases. For some years now geneticists have attempted with fair success to produce plants that are resistant to specific diseases by exposing them to atomic radiation. In all of these cases, disease control has been brought about by the development of plant mutations. A few of the plants subjected to radiation "mutate" or change genetically in such a way that they become resistant to disease. This disease resistance can be inherited by the next generation of plants.

Now Direct Control

Now another step forward has been taken. In the Connecticut Station's Department of Plant Pathology and Botany, plant disease has been checked *directly* by radiation—*all* of the irradiated plants, not just a few mutations, became, to a degree, resistant. The experiments are part of a series conducted in cooperation with the Atomic Energy Commission.

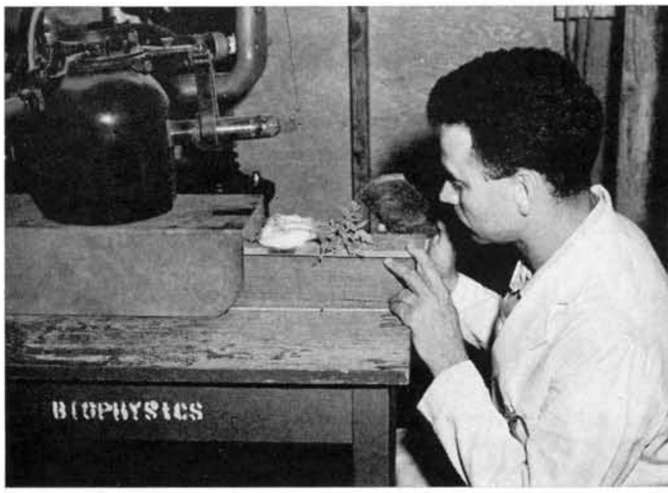
The plants in the experiment where disease was checked by radiation were tomatoes; the disease was Fusarium wilt. The plants were exposed to X-ray radiation several days before being inoculated with the wilt fungus. Other plants, to serve as checks, were inoculated, but were not exposed to X-rays. The irradiated plants were substantially more resistant to wilt than the untreated ones.

The success of the experiment opens up many new possibilities for checking kinds of plant diseases that have been extremely difficult to control in the past. These are the wilt diseases, of which Dutch elm disease, oak wilt, Verticillium wilt of potatoes and eggplant, and Fusarium wilt of greenhouse plants are notorious examples. Since the seat of these diseases is deep within the plant, protectant fungicides are difficult or impossible to apply. "Resistant" varieties have not provided a satisfactory solution since they have frequently been susceptible to new races of the pathogen.

Long Series of Trials

The successful work with Fusarium wilt evolved from a long series of experiments. The approach tried at first was "specific toxicity"—trying to find a dose of radiation which would control the disease without killing the plant. These experiments were unsuccessful; the plants died before the disease was checked. However, an interesting discovery was made—plants nearer the radiation source (in this case gamma radiation in an outdoor field at Brookhaven National Laboratory) were more susceptible than those at a distance. This showed that susceptibility and resistance could be changed. Perhaps the treatment could be changed and resistance increased.

Plants were exposed to high doses of X-rays in New Haven; in some cases entire plants were treated, in others, only part of the plant. Plants exposed in the morning were inoculated with the wilt fungus the same afternoon. Only those plants that were entirely exposed to radiation were more susceptible. When the roots alone were exposed, the plants were more resistant than untreated plants. However, the decrease in disease severity was not yet large enough to compensate for the stunting of the plants caused by radiation. Still further modifications had to be made.



To make them resistant to the Fusarium wilt disease, Dr. Waggoner is exposing tomato seedling roots to X-ray radiation.

The modification that proved successful was based upon experience gained in Dutch elm disease control experiments. There, to be effective, chemotherapeutic treatment must be applied well in advance of disease inoculation. Therefore, the tomato plants were exposed to radiation several days before the plant was inoculated with the wilt fungus. When high doses were used, the plants were almost immune to wilt disease, although they were stunted by the treatment. However, it was found that the stunting difficulty was overcome when only the roots were exposed to a low dose of radiation several days before inoculation.

Successful Method

Thus, we now have a method of controlling Fusarium wilt of tomato. The roots of tomato seedlings are exposed to the wilt fungus. Then, following inoculation with the fungus, the treated tomato plants are larger and less diseased than untreated plants.

These discoveries have given us a better understanding of the mechanism of resistance in plants, and may help us find other methods which will render plants resistant to disease. Radiation may itself prove useful in controlling plant diseases in the field. Although the increase in resistance is temporary and seedlings must be uprooted to treat them, suitable situations could occur to use the method. For example, seedlings uprooted for transplanting could be cheaply irradiated. Then when they were set out a few days later we might find they had a useful resistance to disease while they were becoming established in the field. In addition, further fruitful modifications of the method may make radiation useful in controlling such a disease as Verticillium wilt of potatoes, or potato tuber storage rots, important diseases for which satisfactory controls are not yet known.

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[1] Dr. Waggoner is a plant pathologist.

Blue mold threatened Connecticut's tobacco crop early this season. Here, William Waterman (left), shade grower, and Dr. Taylor examine tobacco leaf showing lesions of the disease.

The Experiment Statio

BLUE mold is the most dread disease of Connecticut shade-grown tobacco. Its large brown, blotchy spots can completely ruin a perfect and expensive cigar wrapper leaf—literally overnight.

The fungus responsible for this sudden disaster is closely related in habits to another, better known disease called late blight of potatoes. The latter is infamous as the cause of the Irish famine late in the 19th century. Fortunately, blue mold has never been charged with murder but it is a chronic thief, stealing thousands of dollars from shade tobacco growers every year.

Outbreak Likely Every Decade

On an average, blue mold reaches outbreak proportions about one year in every ten. In outbreak years, losses may amount to more than a million dollars. Unfortunately, neither growers nor plant pathologists can predict whether a given year will be a severe one or whether bad years might become more frequent than once a decade. It is this unpredictable quality of blue mold that occasions the annual monetary losses to shade tobacco growers. A closer look at how the disease occurs will tell us why.

Blue mold, like late blight, requires both cool temperatures (60° F.) and high humidity (rain, fog, irrigation water) before it can infect the tobacco leaves. Once inside the leaf, the fungus grows as a network of threadlike material called mycelium. The mycelium reaches maturity in six to ten days and only then becomes capable of spreading to other leaves of the plant or to other plants. It does this by producing spores that are blown about by the wind. For this process, as for infection, cool, wet weather is necessary. Neither maturity alone nor cool, wet weather alone can produce spores; both conditions are necessary at the same time. We see, then, that in order to spread and cause severe damage as it did in 1951, blue mold disease requires periodic occurrence of cool, wet weather. Since weather is unpredictable for a whole season in advance, blue mold is also unpredictable.

Fungicide Best Control

A grower's best protection is to keep the leaves covered with a fungicide at all times so that any blue mold spores landing on the leaf will be killed before they can enter the leaf tissue. This sounds easy but the tobacco plant grows very rapidly and additional fungicide must be applied every four days to keep the new growth protected. Rapid growth also means that aircraft must replace ground equipment early in the season. The seasonal cost of such a protection program may be well over 60 dollars an acre.

The aim of blue mold research at the Tobacco Laboratory in Windsor and at the Station in New Haven has been to eliminate or reduce these costs. Four approaches are currently being followed in this research. First is development of a shade tobacco variety that resists blue mold infection. This requires long years of crossing and testing among many lines of tobacco, plus the final bridge of trade acceptance for any new strain. Plant breeders in the U. S. Department of Agriculture at Beltsville, Md., have been successful in crossing resistant tobacco with our Connecticut shade types. Now we are in the long pull of selection for a plant that is both resistant to blue mold and true to the high quality of Connecticut shade tobacco.

The second approach is a continued search for newer fungicides that will do a cheaper and better job than those now available. In this field, shade tobacco presents a unique problem. Each of the eighteen harvested leaves on a shade tobacco plant produces four or more cigar wrappers. Since these leaves are essentially the cigar's outer packaging, they must be uniformly colored and free of any blemishes. That is why blue mold spots are so disastrous. Even though a fungicide may control blue mold, it is worthless if it in turn causes spots or unsightly residues. Research at the Tobacco Laboratory has shown that most wettable powder sprays do leave unsightly residues. Dusts are less likely to do this because the carrier material blends with the color of the finished leaf.

Presently three carriers are available but only one fungicide has been found satisfactory in the field. This is called zineb. New fungicides are being tested every year but so far none has proven better than zineb for field treatment of blue mold on shade tobacco.

The third phase of blue mold research involves a technique developed by this Station while studying Dutch elm disease and Fusarium wilt of tomatoes. It is chemotherapy, or the control of disease by chemical compounds acting inside the plant. Such an approach might provide a longer period of protection from one treatment than the four days afforded by externally applied fungicides.

Blue mold in the seedbed can make young tobacco plants look like this. Entire beds can be killed by the disease.

Saul Rich working in New Haven pioneered the use of this method against tobacco blue mold. Results of work initiated by Dr. Rich have shown that under controlled greenhouse conditions certain compounds applied only to the roots do act internally to give protection against blue mold for at least ten days. Results with plants grown outdoors have not been conclusive but research is continuing.

Fights Tobacco Blue Mold

by Gordon Taylor[1]

The method's main application may well be in the seedbed stage rather than in the field. In tobacco seedbeds temperature and moisture conditions are often ideal for spread of blue mold. Seedbed plants are now protected through biweekly sprays or dusts, necessitating removal of the seedbed sash which adds to the labor costs. If a compound could be applied through the watering system in low concentrations and be taken up by the plant to act internally, a great saving could be effected. As yet, concentrations and amounts of material necessary for seedbed conditions have not been satisfactorily worked out.

Disease Forecasts

The fourth research approach is to find a way of predicting when blue mold is likely to become dangerous during any given season. Much progress has been made in this direction by Paul Waggoner of our staff. He is using a specially constructed shade tent at the Mt. Carmel Experimental Farm near New Haven where introduction of blue mold will not endanger growers in the tobacco area. Dr. Waggoner traces the pattern of blue mold spread from a single plant to its neighbors. He then correlates this pattern with a continuous record of weather conditions under the tent. He has found that blue mold can spread even though the proper conditions occur for only part of a day. The direction and distance of such spread is probably determined by the wind direction and velocity. Further studies of this type should provide an accurate picture of the conditions necessary for blue mold to become serious.

Using this knowledge, a blue mold prediction might work this way. Suppose that we know weather conditions were favorable for blue mold spread on July 1. We also know that a few blue mold spots are present in shade fields. This means that on July 1 many new infections probably occurred. These new infections will produce spores about July 7 if the weather is again favorable. This time the amount of spread would be great since there is more blue mold around. The knowledge that an infection period had occurred on July 1 and another could occur on July 7 would be passed on to growers who would then apply the protective fungicides before the July 7 period arrived.

Obviously this scheme requires not only accurate data on weather conditions under shade tents but also accurate knowledge of the presence of blue mold and its geographical location as the season progresses. Information on the presence of blue mold comes from growers, from county agents and from observations by members of the Windsor staff. First occurrences of blue mold in the seedbed and in the field and any major change in the status of disease development during the season are publicized generally in newspapers and on the radio so that all growers may be aware of the situation. Further, this information is submitted to the Plant Disease Warning Service of the U.S.D.A. which makes it available to authorized plant pathologists everywhere in the United States. The warning service in turn provides us with information on blue mold outbreaks in other tobacco growing areas, thus preparing us for possible trouble here in Connecticut.

Warning service information plus continuous weather data from the shade tobacco areas should allow prediction of at least the first periods of major spread in any given year. Organizational arrangements have already been made for providing this service in the 1955 season. We have not yet had enough experience to be completely sure of the prediction every time but results in 1954 were very encouraging.

Infection in 1954

In one shade-grown area this year a severe infection on young plants was in danger of spreading seriously and was so predicted. As it happened the weather was cool and wet enough but lack of wind at the same time resulted in only very localized spread. A few bents in many widely scattered fields were badly diseased but the Valley as a whole escaped lightly. This was undoubtedly due in part to the rather intensive dusting schedule observed by most growers.

We hope that in the not too distant future accurate predictions of disease spread, improved control compounds, perhaps acting internally, and a basically high degree of natural resistance in the growing tobacco may well remove the dread from the headline "Blue Mold Found in Valley Shade."

[1] Dr. Taylor is assistant to the Station Director, in charge of the Tobacco Laboratory at Windsor.

Paul Waggoner, plant pathologist, checks the temperature and humidity in an experimental shade tent. These two factors have much to do with the spread of blue mold, and weather data aids in predicting when an outbreak will occur.

From the Director

Many people look upon us here at the Experiment Station as fire fighters and we are proud of this reputation. The "fires" we fight cover the whole range of problems in plant growing and some others, besides—apple scab in the orchard, fertilizer deficiencies on the farm, ants in the gardener's lawn, silverfish in his library, poisoning of pets, analytical data for the courts, gypsy moths in the forests, mosquitoes in the drive-in movies. The fires we fight are both big and small ones.

We can fight these fires much more efficiently if we can guess ahead of time where they are likely to break out. Research at its most effective is forearmed research.

Locating Trouble Spots

How do we guess where the trouble spots are apt to be? Two examples will suffice. Right after World War I, a new disease began to decimate the elms of Holland. By 1927, the Dutch elm disease was raging over all of northwestern Europe, and had leaped the Channel into England.

Dr. G. P. Clinton, chief botanist at the Station at that time, believed that the elm trees were an integral part of New England's beauty and a trademark of the area. If the elm disease broke out here, it could be catastrophic. So, before this occurred, Dr. Clinton went to Holland to study the disease. The disease did, of course, bridge the ocean and hit our elms, but we gained valuable lead time on it from Dr. Clinton's trip abroad. Dutch elm disease is extraordinarily difficult to deal with, but research has enabled its partial control. In 20 years, it has not caused nearly as much damage as the chestnut blight did in four or five.

A second example concerns DDT. In 1945, when laymen first used DDT, it was the wonder bug killer. What it did to flies in dairy barns and restaurants was nothing short of miraculous. In 1947 came the first sign of trouble. A scientist in *Italy* reported that he had found houseflies that could not be killed with DDT. Our entomologists promptly decided that resistance might develop in Connecticut insects, and set to work to have an answer ready when the problem arose.

Neely Turner and Raimon L. Beard of our staff began their investigation of resistance in 1948. They found that a few insects are normally resistant to insecticides and that, if the susceptible individuals of a species are killed, the resistant ones repopulate the area. They found that if two insecticides are mixed and applied together, the chances of resistance are far less than if the two chemicals are applied in succession.

In 1952, flea beetles in Connecticut potato fields began to show resistance to DDT. The following year the same problem was encountered with cabbage worms on cabbage. In both cases our entomologists were prepared. Because they had guessed five years before that the fire would break out, mixtures of insecticides were at hand for farmers to use against these insects and both flea beetles and cabbage worms are being controlled successfully.

But research does not stop with putting out fires, either already existent ones or those envisioned in the future. Research must break new paths that enable agriculture to do things it never did before. Science so advances by studies of the fundamental laws of nature.

Sometimes this basic research looks sterile. When Faraday was studying the principles of electricity one hundred years ago, someone asked him "What good is it?" To which Faraday replied, "What good is a new born baby?"

Hybrid Corn

When our Dr. Jones first produced a new type of corn back in 1917, no one predicted that in less than 40 years, 90 per cent of the nation's field corn acreage would be planted to his double-cross hybrids. When Osborne and Mendel, working in our chemistry laboratory at about the same time, discovered that chickens could be raised indoors, they were trying to learn more about the vitamins they had helped to discover. They had no idea that this one phase of their experiments would help develop a whole new industry. The hundreds of poultry houses in Connecticut today are concrete evidence that it did, however.

The research man, then, is a fire fighter. He is also a fire watcher. Most important of all, he is an investigator of things that are not afire, an asker of questions, a seeker after new knowledge, one whose curiosity about nature is insatiable.

James G. Horsfall

THE TOOLS OF SCIENCE:
Tobacco Curing Cabinets

by A. B. Pack [1]

Cabinets like the one pictured below are used at the Windsor Tobacco Laboratory to study the curing of tobacco under controlled atmospheric conditions. There are six such cabinets, each of which is supplied with air at controlled temperature, relative humidity, and velocity. The temperature of the air can be regulated from room temperature to 105° F., the relative humidity from 20 to 95 per cent, and the air velocity from about 15 feet to 35 feet per minute. Any combination of atmospheric conditions encountered in regular tobacco barns during the firing of the crop can be attained with the exception of high air velocities. Atmospheric conditions can be kept constant in the cabinets throughout the curing period or varied from time to time.

It is thereby possible to investigate the role of atmospheric factors on the curing process and how each affects water loss, color changes, and quality of the cured product. We can investigate the effect of environment on the many chemical changes that go on during curing and, in turn, the effect of these chemical processes on the leaf properties which the cigar industry associates with quality.

The cabinets are supplied with air from a large air-conditioner, similar in type to those used in commercial air conditioning. After the air is heated and humidified to the right degree, it is blown through ducts into the cabinets and returned to the conditioner to resume the cycle. Temperature and humidity are regulated by sensitive control devices.

[1] Dr. Pack is a plant physiologist whose special field is investigation of the tobacco curing process.

REPORT ON THE GYPSY MOTH

by Neely Turner[1]

The 1954 infestation of the gypsy moth in Connecticut was the most widespread on record. Scouts found almost 200,000 acres of woodland so heavily infested that serious defoliation was threatened. The most seriously infested area was in Hartford County west of the Connecticut River, and in southeastern Litchfield County. Less extensive infestation occurred in Middlesex and New Haven counties and in the northern part of Litchfield County.

36 Towns Infested

Thirty-six towns were involved in the outbreak. Governor John Lodge, acting on the suggestion of representatives of the affected towns, made available emergency funds to assist towns and owners of woodlands in large-scale spraying. Twenty-four of the most heavily infested towns sprayed all of their infested woodlands, and large areas in six other towns were sprayed by owners of the woodlands. The area sprayed was 121,308 acres at a cost of $87,910 to towns and owners and $67,932 of State funds. In addition, about 12,500 acres of State Forests and Parks were sprayed.

The spraying operation was very effective. In most towns the application was completed before the caterpillars had damaged the foliage. The only difficulty was encountered in Litchfield, where up-drafts along hills prevented the spray from settling properly. This small area of about 200 acres was re-sprayed and the caterpillars killed. However, some serious feeding occurred before the re-spraying was completed.

Spraying by helicopter for control of the gypsy moth in a woodland area in Litchfield County.

In the unsprayed areas, about 14,000 acres of woodland were seriously damaged by the gypsy moth. Cool, rainy weather during the period the eggs hatched, abundance of parasites, and the occurrence of a wilt disease of the caterpillars helped to reduce the area defoliated.

It is as yet too early to make any accurate estimate of the degree of infestation in 1955. No new infestation has been found in any of the seriously infested towns which were sprayed in 1954. Several unsprayed areas heavily damaged in both 1953 and 1954 have little new infestation, as expected.

Intensive scouting in the unsprayed areas has started and will be continued. It is in these areas that any serious infestation may be expected in 1955.

Spraying Expensive

The expense of spraying as a method of control of this pest has led to a re-study of control by other means. Parasites of the gypsy moth are well established in the State and kill a large proportion of the population. However, parasites alone have not prevented outbreaks—they are actually most effective *after* the gypsy moth produces a large population. Predatory rodents help keep the gypsy moth under control in the eastern part of the State. The ground cover in much of the heavily infested western area is not suitable for development of the rodent population.

The 1954 "outbreak" demonstrated once more that the gypsy moth is a serious pest only on those woodlands which are composed mostly of gray birch, poplar, white, black and chestnut oaks. Areas in which the proportion of these trees is low were not heavily infested. Large acreages of beech, yellow birch, maple, and red oak were not damaged. Similarly, woodlands containing large numbers of pines and hemlocks were not seriously infested.

Reduce Susceptible Species

It is obvious that reducing the percentage of gray birch, poplar and white, black and chestnut oaks in the highly susceptible woodlands and increasing the number of beech, yellow birch, maple, pine and hemlock trees would reduce the danger of gypsy moth attack. Such a method of "preventing" infestation was proposed in 1936 by C. E. Behre, A. C. Cline and W. L. Baker in Bulletin 157 of the Massachusetts Forest and Park Association.

Unfortunately, much of our heavily infested woodland consists only of susceptible trees. A change in the trees under such conditions might be both difficult and expensive. The presence in these areas of gray birch, poplar and oaks is probably the result of the way the forest has been handled in the past. Abandoned pasture has grown up in gray birch and poplar except where white pine seed trees were present. These species are short-lived, and have been followed in many cases by oak. Mixed forests which were clean-cut and burned have been followed by oaks, because the young conifers were killed and only the durable oak seeds were left.

The type of management used to improve woodlands of this sort must depend on the use for which the crop of trees is grown. In the recent past, woodlands have been improved for either production of timber or for recreation. Obviously, only a small proportion of the 2,000,000 acres of woodland in the State is required for recreation. The possibility of profit from production of oak timber on much of the area heavily infested by the gypsy moth is not promising. The oaks do not grow rapidly on the light, sandy soil. On these unfavorable sites, which were probably originally growing pines or hemlocks, the value of the annual growth of oak has been estimated at about 50 cents an acre. On the sites which have mixed stands containing susceptible trees, removal of some of the favored hosts would result in fewer gypsy moths. In many areas an understory of white pine can be released.

The Connecticut State Board of Fisheries and Game has proposed a program for development of forest game. The practices and principles of this program include development of "mixed stands of hardwoods and conifers, mantaining a scattering of many tree species, and aimed toward an uneven or all-age stand harvested on a substantial yield basis." This type of woodland should be very resistant to gypsy moth attack, and offers a third use for large areas of woodland.

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[1] Mr. Turner is head of the Station's Entomology Department.

Chemotherapy Checks Lettuce Disease

by Saul Rich[1]

The chemotherapy project has paid dividends again. Experiments just completed demonstrate that chemotherapeutants may be used to control lettuce big-vein.

Big-vein of lettuce is a soil-borne virus disease which has caused considerable loss to Connecticut lettuce growers during the past ten years. Plants infected with big-vein are stunted and show very large, clear veins, hence the name of the disease. Although soil fumigation with chlorpicrin or formaldehyde can rid the soil of the active virus, the method is fairly expensive and cannot insure against recontamination. Hence, no practical control has been available.

Chemotherapy offered hope. If an effective material were found, it could be watered on healthy seedlings to make them resistant to big-vein before the lettuce was set out in an infested field. Such a material would fit in readily with the farmer's growing methods as it could be applied to the seedlings in cold frames during regular watering.

Proven Materials Picked

The materials chosen to be tested were ones which are effective against other plant virus diseases. Zinc sulfate and calcium chloride had been shown by E. M. Stoddard of this Station to be chemotherapeutants for X-disease of peach. The other materials chosen were growth regulators, a group of compounds demonstrated here to be effective chemotherapeutants by David Davis and A. E. Dimond.

Various dilutions of materials were sprinkled on flats of healthy lettuce seedlings at the rate of a pint per flat. The applications were made twice a week for a total of six times. One flat received plain water each time as a check. About one month after the last treatment, the plants were set out in a field heavily infested with the big-vein virus. They were fed no more chemotherapeutants.

Hopeful Results

The results were encouraging. The plants from all treatments had significantly less disease than the check plants, 86 per cent of which showed leaf symptoms. The growth regulators reduced leaf symptoms the most. Of the three growth regulators tried, however, only 2,4,6-trichlorophenoxyacetic acid had no bad effect on heading or yield. While not as effective as the growth regulators, both calcium chloride and zinc sulfate also reduced the amount of disease, and had no adverse effect on the plants. Surprisingly, zinc sulfate increased yields 22 per cent over the check. It was the only material to give this effect. Zinc sulfate may have increased yields in either of two ways. First, it may have remedied an undetected zinc deficiency. Second, zinc sulfate may have overcome the stunting effect of the virus to a greater degree than it suppressed the visible leaf symptoms of the disease.

Chemotherapy, then, can be used to protect lettuce seedlings against the effect of the big-vein virus. Of the materials tested, 2,4,6-trichlorophenoxyacetic acid and zinc sulfate were the most satisfactory. Of the two, zinc sulfate is probably the one most likely to achieve practical use, because it is cheap, easy to get, and water soluble. The dilution of zinc sulfate used, 250 parts per million, is equivalent to 1½ ounces per 50 gallons, or 1 teaspoonful per 6½ gallons.

It must be emphasized that these data are the results of only one year's testing. Any grower who wants to try the new treatment should do so on a small, trial basis only.

[1] Dr. Rich is a plant pathologist.

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List of New Station Publications

BULLETINS

581. Preservation of Wood by Simple Methods.
582. Report on Commercial Feeding Stuffs. 1953.
583. Studies of Soil Fauna with Special Reference to the Collembola.
854. The Morphology, Mineralogy and Genesis of Two Southern New England Soils.

CIRCULARS

187. Commercial Peat and Native Organic Materials in Connecticut.
188. Ants As Pests.
189. The Toxicity to Plants of Wood Preservatives and Their Solvents.

SPECIAL

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