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SPRING ISSUE

CONNECTICUT AGRICULTURAL EXPERIMENT STATION, NEW HAVEN

POTATOES AND DDT

by Neely Turner [1]

The introduction of the insecticide DDT has gone far toward solving the problem of protecting potato foliage. Before DDT was available, growers had to rely on high concentrations of Bordeaux mixture to repel flea beetles and control leafhoppers; on calcium arsenate for Colorado potato beetles, and on nicotine for aphids. DDT has taken care of the first three of these pests very efficiently, and in the emulsion form has been reasonably effective in killing aphids.

Can Use Organics

Most important of all, DDT has made it possible to use organic fungicides for the control of potato diseases. Prior to the use of DDT, Bordeaux mixture was relied upon both to kill insects and to control diseases.

While this material gave excellent control of many potato insects and diseases, it was, at the same time, injurious to potato plants. Only the fact that increases in yield from pest control more than offset this injury made Bordeaux mixture usable. With the advent of DDT, it was no longer necessary to use Bordeaux mixture for its insecticidal value, and the organics, which have little or no insect-killing properties, could be used to control such diseases as late blight, early blight and Botrytis. The organic fungicides are much less injurious while giving equally good control of diseases and DDT has enabled the growers to use them profitably. Tests have also shown that DDT itself causes considerably less injury to plants than Bordeaux.

However, although the excellent control of pests with DDT has resulted in record production, our tests have shown that DDT-treated plants yield about 5 per cent less than the production we would expect if there were no chemical injury to the plant at all. DDT emulsions have been much more injurious than the spray powders, probably because of the presence of the solvent in the emulsion.

What about DDT residues left in the soil? Are they harmful to plants? Preliminary studies by the United States Department of Agriculture show that potatoes are not harmed by DDT in the soil, but that the insecticide does interfere with the germination and emergence of legumes and of some grass seeds.

Use When Needed

So we find that DDT sprays do have at least a slightly injurious effect on potato plants, and that DDT residues in the soil may be harmful, if certain crops are grown following potatoes. Neither of these are reasons for discontinuing the use of DDT on potatoes, but rather warnings that it should be used only when it is needed instead of continuously throughout the season.

It is obvious that the ideal spray material is one that effectively controls pests, causes no injury whatever to the plant, and leaves no harmful residue. Until such an ideal is reached, it is necessary to make the best possible use of the materials available now. On the basis of the facts developed by research, the most logical system for control of potato pests seems to be:

Control Steps

(1) Application of DDT spray powder twice early in June to kill flea beetles and Colorado potato beetles and about three times in July to control these insects and leafhoppers; (2) Use of DDT emulsion as needed for aphids during August, or substitution of emulsion for spray powder if aphids become abundant in July; (3) Addition of nicotine to DDT emulsion if the emulsion fails to control aphids late in the season; (4) Use of a fungicide, such as Dithane, one of the fixed coppers, or Bordeaux mixture, from July 1 until September 15 for control of blight.

Such a schedule should result in maximum control of pests without excessive use of DDT and should, therefore, produce maximum yields.

[1] Mr. Turner is an entomologist.

Experimental sprayer for small plots of potatoes. Miss Nancy Woodruff, the spray operator, opens a valve on the side to be sprayed. Plots are usually 15 to 25 feet long and 3 feet wide. Materials that perform well on small plots are then taken to commercial fields for large scale tests.

Wood Lasts Years Longer With Preservatives

by H. W. Hicock [1]

A. R. Olson of the Forestry Department examines a post destroyed by wood-rotting fungi. Post at right, in service for the same number of years, had been treated with preservative and escaped decay.

Each year millions of dollars are lost through the work of wood-rotting fungi. These organisms thrive on cut wood everywhere and attack in such widely varied places as farm buildings, greenhouse benches, fence posts and tobacco tent poles. Much of this ruination of good wood can be prevented.

Various forms of preservative treatment have been developed which will make non-durable timbers resist rot and decay as well as or better than woods which are naturally resistant.

Three Types

Preservative chemicals are classified as oily (creosotes), oil-soluble (napthenates of copper, zinc and other metals and pentachlorophenol), or water-soluble (zinc chloride, copper sulfate, sodium fluoride and mercuric chloride). Each type has its advantages and its limitations. The oily or oil-soluble preservatives are not readily leached out of wood while water-soluble materials will disappear in time from leaching. The water-soluble materials, however, have in their favor the fact that they may be used on either seasoned or unseasoned wood, while the other two types are limited to well seasoned wood which is free of bark. Wood treated with water-soluble or oil-soluble preservatives takes paint satisfactorily, while the creosotes strike through paint coatings and may be objectionable in certain locations, because of their odor or their injury to plant tissue.

Selecting the Treatment

In selecting the material and method of treatment, the conditions under which the wood will be used must be considered carefully. Decay is most severe when wood is in contact with the soil or when it is continuously exposed to a warm, damp atmosphere. In such cases, treatment should extend inward from *all* surfaces for at least ¼ inch. Superficial treatments by spraying, dipping or brushing are of little value here.

If the capital investment is high, and conditions favoring decay are severe, as in the case of floors laid on concrete, foundation sills and lumber for porches, the very best possible treatment is the only worthwhile one. This is most effectively done in commercial plants where the preservative is applied under pressure. Where high initial costs cannot be justified, as in the case of farm fence posts, the owner or small operator can use methods which will give results commensurate with the cost.

Work at the Station has been confined primarily to experiments with two preservatives on a miscellany of woods. In the early work creosote was applied to peeled, well seasoned posts by the open tank method at temperatures of 215-220°F. Most of these posts received butt treatment only, the tops being untreated.

A survey of some 3,500 of these posts after 12 years of service showed that the butts were still in excellent condition. The untreated tops, however, showed excessive decay, indicating that, in this climate, it is absolutely essential to give posts and poles a full length treatment.

Zinc Chloride

More recently, Station work in wood preservation has dealt with the use of zinc chloride. The principal objection to this material is that it will eventually leach out of the wood. Advantages are that the salt is cheap and may be applied effectively to either seasoned or unseasoned wood with very crude equipment by simple immersion or other methods which assure a full length treatment of the post or pole. Field tests on farm fence posts and tobacco poles of maple, birch, pine and spruce treated in 1938 with zinc chloride, at the rate of about one pound of dry salt per cubic foot of wood, are still in excellent condition both above and below ground.

[1] Mr. Hicock is head of the Forestry Department.

Fence posts last longer if pretreated with preservatives before being set. This post and railer will give good service for many years.

Chemotherapy Gets to

by A

Treating plants for disease from the "inside out". Instead of spraying the foliage, the conventional method, chemotherapy puts the "medicine" on the soil around the plant. From there, the plant absorbs it through its roots and distributes it evenly in the stem and leaf.

Everyone who grows plants has known the bitter experience of seeing a prized plant or crop suddenly wilt and die without apparent reason. The eggplant grower who can raise a crop without some loss from wilt is lucky indeed. The flower grower usually loses some asters each year from similar cause. People who are tree conscious are well aware of what Dutch elm disease is doing to the elms of New England. These are all examples of kinds of diseases which attack the parts of a plant whose main function is movement of water to the leaves. By upsetting these water relations, by producing poisons in the main water channels of the plant, the fungi which cause these diseases affect the plant throughout.

Internal Medicine

Such diseases are internal, and plant scientists at the Connecticut Agricultural Experiment Station have recently been learning how they may be controlled by putting the principles of internal medicine to work. If you get diphtheria, the microbes which cause it are not themselves the cause of illness. These bacteria liberate toxins into the blood stream which are the real cause of disease. Physicians have long since learned how to prevent diphtheria by putting antitoxins for diphtheria into the body and so minimizing the effect of this once dreaded disease. In the same way, plant scientists are finding out what kinds of chemical compounds may be placed inside the plant to combat internal diseases. Because these diseases have never been satisfactorily controlled before, the merest indication that they may be prevented by chemotherapy has great promise to growers.

We know of cases where a plant is made resistant to a disease because it produces the proper chemical. Onion growers have known for years that white onions are very susceptible to onion smudge, a disease which attacks the outer scales of the bulb. In contrast, yellow and red onion varieties are resistant. A few years ago, scientists at the Wisconsin Agricultural Experiment Station learned that the colored varieties of onion contain a particular chemical compound, protocatechuic acid, which was lacking in white onions. This compound makes the colored varieties resistant to disease. In this case nature places the chemical in the plant.

What nature does, man can imitate. If nature can find chemical compounds that make a plant resist disease, man can find others, and place them in the plant. This, in simplest terms, is what the chemotherapeutic studies at the Connecticut Agricultural Experiment Station are attempting to do.

Plants, unfortunately, do not have a blood stream by which an introduced chemical compound may be distributed uniformly and quickly. We have had to develop methods that permit adequate distribution by other means. The cover picture shows how this is done in our experimental work. In solution, the test compound is applied to the soil in which the plant is growing, and the plant absorbs it through its roots and distributes it in the water stream as water rises to the leaves.

We have learned already that several

This tomato plant received no chemical treatment and shows the effect of Fusarium wilt. The leaves have wilted or collapsed. The plant will eventually die.

Left: Disease has been prevented by t[...] plant where the disease has develope[...] amount of wilting. Also the stems will [...] vessels. Such blackening means poor w[...]

...e Heart of the Matter

...Dimond [1]

kinds of diseases may some day be controlled in this way. The X disease of peach becomes much less severe in trees which take up calcium chloride from the soil. When diseased buds are grafted into healthy trees, they will make the entire tree become sick. But if this is done on trees which have received soil applications of the proper chemical compounds, the tree remains healthy.

Dutch elm disease may be controlled to some degree by chemotherapy. Trees receiving treatment with oxyquinoline benzoate appear less likely to become diseased than trees that are not treated. The pictures indicate very clearly how well treatment with the proper chemicals may hold Fusarium wilt on tomato in check.

As we learn more about the ways in which internal medication can be used to control plant diseases, we shall approach the day when these findings go to work for the farmer. That is yet a long way off on any large scale, but already there are some operations based on chemotherapy which are ready for commercial practice.

Dutch Elm Disease

In Dutch elm disease control, oxyquinoline benzoate has been applied with some success for three years now to protect healthy trees against infection. On New Haven's historic Green, some of the elms have been treated and some have been left untreated. After three years' treatment, 5 per cent of the treated trees have become infected while 15 per cent of the untreated trees have become diseased. In other experimental plots the response has been superior to this.

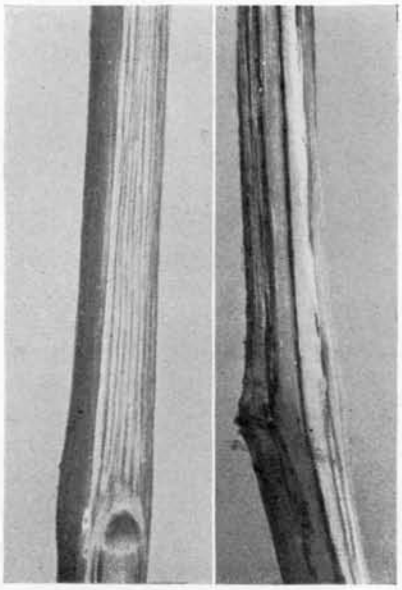
Years ago, we used to think that chemotherapy was worth developing only for "luxury" crops like elm trees and other plants worth a great deal on a plant basis. We no longer believe that this is true. Already it is evident that greenhouse operators grow their crops under conditions almost ideally suited for using chemotherapy without appreciable change in their growing methods. Particularly where plants are grown in gravel culture, where nutrient solutions are circulated by pumps about the roots of plants as a routine operation, it would be possible to add a chemotherapeutant to reduce disease losses, with no change at all in the usual procedure.

While most of the investigations so far have been concerned with applying the medicines to the roots of plants and letting the plant absorb them through their roots, this method may not be essential to success. We must yet learn how to compound these chemicals so that, when applied as a foliage spray, they will be absorbed through the leaves and penetrate the plant. Most vegetable growers are equipped to apply foliage sprays. If we can successfully apply chemotherapeutants to the foliage, the technique comes within the reach of all kinds of growers.

Chemotherapy is indeed a frontier of plant science. The theory is still largely unknown; the possibilities are tremendous.

...nt with an effective compound. Right: Untreated ...hecked. Dr. Dimond examines plants for the ...amined for blackening of the water-conducting ...ovement.

After treatment with an experimental chemical, the plant is inoculated with a disease and is repotted in a clean pot with fresh sand. Here, Miss Barbara Wooding inoculates a tomato plant by dipping injured roots in a suspension of the fungus causing Fusarium wilt.



Differences in stem blackening in treated and untreated plants. Left, treated. Right, untreated.

[1] Dr. Dimond is assistant chief, Plant Pathology Department.

From the Director

The land and the plants and animals that grow on it is the most important natural resource which we, the people of the United States, possess, for it is the land that supplies our food. Society has a basic interest in seeing that its food supply is adequate. No free state lives long when hunger stalks the land.

Society can no longer turn to the West for more land to grow crops; our reservoir of land for expanding acreage has been exhausted. Yet our population continues to grow. The answer then must be in increased efficiency, in seeing that more food is produced on fewer acres.

Scientific research is the bulwark against shrinkage in our food supply. Research on pests, for example, shows the way to reduce their consumption of food and save it for society.

Food for man is produced when plants are healthy and well nourished by minerals, water and sunlight. Research on plant nutrition, therefore, pays handsome dividends in fundamental knowledge and in new food supplies for society.

The miracles resulting from scientific research do not just happen between trains. They come from long years of patient counting, weighing, measuring and calculation.

Hybrid corn, a basic contribution of the Connecticut Agricultural Experiment Station, was conceived during World War I. It did not add anything to that war, but patient research in experiment stations all over the country during the 20 years between made possible the tremendous contribution of hybrid corn to World War II. The nation produced about twice as much corn per acre during the last war as it could in 1918.

Mr. Euclid said that "Things equal to the same thing are equal to each other". Food is a natural resource. Research produces food. Therefore, research is a natural resource.

Determination of Vitamins in Feeds Simplified by New Extractor

by H. B. Vickery[1]

The development of new apparatus or equipment to speed or facilitate work in the scientific laboratory is an important function of any research institution. The Connecticut Station has many such innovations to its credit.

Probably the best known of these is the equipment used universally in the Kjeldahl process for determining the nitrogen content of feeds and fertilizers. The elaborate modern device is the lineal descendant of homemade apparatus designed in 1886 by the first Director of this Station, Professor Samuel W. Johnson, and is used today in agricultural and biochemical laboratories all over the world.

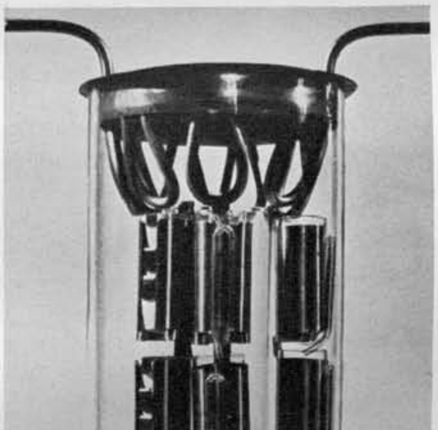
There are many other examples of the inventive skill of past and present members of the staff currently in use here and elsewhere. The most recent is the extraction apparatus shown in the illustration. Developed by Mr. Laurence S. Nolan of the Department of Biochemistry, this device was designed to increase the efficiency of the determination of the vitamin D content of poultry feed supplements. In this procedure, commercial products are fed in the laboratory to chickens. Later, the chickens are killed and their bones are examined to see if the vitamin D supplied in the food was sufficient for good growth. As as essential part of the analysis, the fat must be extracted from the bones and for this purpose Mr. Nolan's apparatus is employed. With a full equipment of the holders shown, 18 samples of bones can be extracted simultaneously with corresponding increase in efficiency.

Extractor Has Many Uses

The extractor was soon found to have many other applications and is now used for a variety of purposes in the laboratory. By the use of crucibles in the holders, as shown below in the picture, no less than 54 small samples can be extracted at the same time. With a few additional simple glass parts, the apparatus can be used in research upon the oil and also the proteins of plant seeds. When the condenser cover is placed on a taller jar, with a suitable funnel and glass cylinder within, the device can be used for the continuous extraction of water solutions with ether, a convenient method for the separation of nicotine from tobacco or of organic acids from extracts of plant leaves.

For all of these purposes, the jar, containing an inch or so of organic solvent in the bottom, is heated on an electric hot-plate and a stream of cold water is passed through the condenser tubing. The boiling solvent is condensed by the loops of tin tubing hanging from the cover so that it drips continuously from each loop into the extraction cup or crucible held beneath it. The material being extracted is suspended in the hot vapor so that the solvent is used at its maximum efficiency. The device runs continuously without attention until the extraction is finished, and has been employed with complete success for the past two years.

[1] Dr. Vickery is head of the Biochemistry Department.



Recently designed Nolan extractor which has made possible more efficient determinations of the vitamin D content of poultry feed supplements.

STATION FIELD DAY

FRONTIERS readers are cordially invited to attend the Station's 34th annual Field Day which is scheduled this year for August 24. The event, open to all interested in agricultural research, will be held at the Station's Experimental Farm, Mt. Carmel.

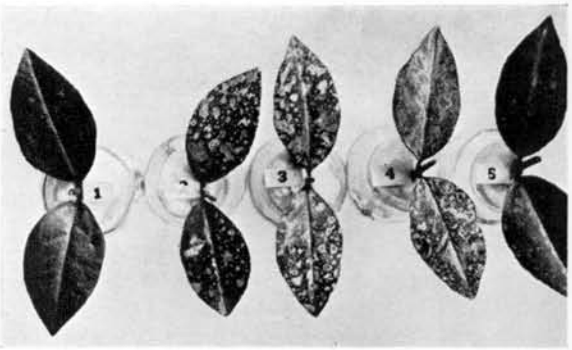
This will be the only Field Day held during the next two years. In 1950, the Station will hold its 75th Anniversary Celebration and Field Day will be omitted for that year.

WHAT MAKES A STICKER STICK?

by Philip Garman[1]

Fruit growers like sprays that stick. A material, even if it gives good insect and disease control, isn't of much value if it washes off with the first rain and has to be reapplied after each shower.

A long time ago the good sense of adding materials to the spray mixture which increased its adhesiveness to the leaves was seen, and scientists have, for many years, been searching for new and better stickers.

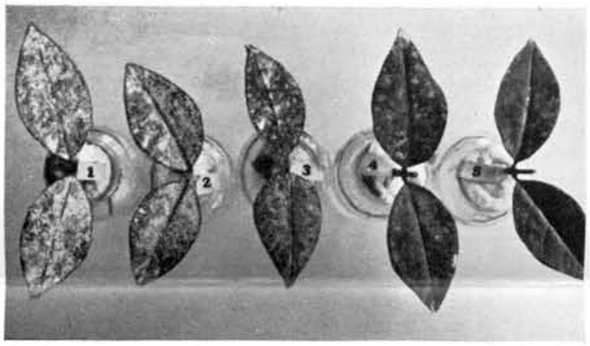


Skim milk and bentonite together make a good sticker for lead arsenate and flotation sulfur sprays. Leaf 1 received bentonite but no skim milk, Leaves 2, 3 and 4, the same amount of bentonite and gradually increasing amounts of skim milk, Leaf 5, neither material.

Trial and Error First

At first, they did this largely by the trial and error method. Picking out materials which they knew were naturally tenacious, such as oils, gums, glues and clays, they simply combined them with insecticides and fungicides and their ability to adhere to foliage was observed. In view of the variability of weather conditions, the end results were necessarily variable and oftentimes unreliable. While this shot-gun method of approach resulted in some useful facts, it gave us little indication of why stickers stuck or, except in a general way, which sticker was best.

In order to provide quicker and more reliable results, techniques have been developed in our laboratory whereby we can tell within a few hours whether or not the standard sprays adhere better with a particular sticker. Glass slides or foliage are sprayed with sticker combinations and then given a severe washing test. Slides are moved back and forth for a definite number of times in distilled water, and foliage is washed in a specially devised rain machine.

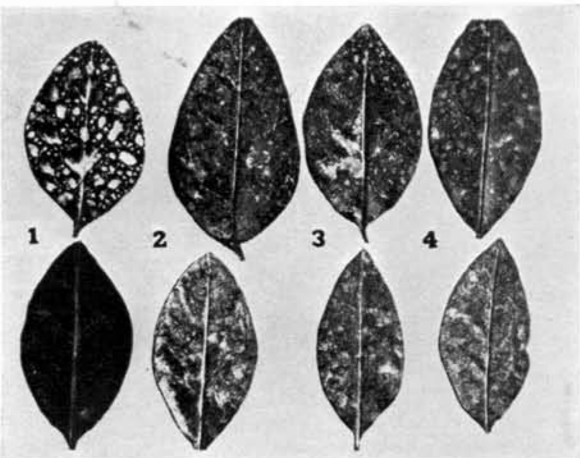


Here, lead arsenate and sulfur with bentonite already added was sprayed on each leaf. Skim milk put on in decreasing quantities from left to right. No skim milk on Leaf 5.

Using these new techniques, it was soon learned that some commercial stickers were worse than none. Casein-lime, widely used at one time, gives very little adhesion when the ratio of lime to casein is 3 to 1 (the prevailing ratio) but has good tenacity when the ratio is 1 lime to 3 casein. Kolofog, a bentonite sulfur, stuck well when lime was added and very well with skim milk powder.

Oils, of course, are very effective stickers and, when combined with clays, act also as deposit builders. One oil-containing mixture is bentonite-skim milk-oil which we have used now for a number of years with Fermate as the fungicide. With this combination, it is possible to reduce substantially the number of sprays necessary for good pest control. Unfortunately, one of the important elements in this sticker is oil, and oil is not compatible with sulfur—that is, it increases spray burn.

We are now trying to increase the adhesiveness of sulfur-lead arsenate mixtures without conflicting with the sulfur. Of the many products we have tested in the laboratory, synthetic vinyl resins are among the most promising.



New synthetic vinyl resins show up well as stickers. Increasing amounts of the compound added from left to right. No stickers on Leaf 1. Upper row of leaves unwashed.

Physics Gives Clue

To go back to the question—what makes stickers stick to foliage? We know that the phenomenon is closely tied up with chemical and physical properties. For example, clays that do not swell and form gelatinous masses or colloids on addition of water are not as adhesive as materials that do, such as Wyoming bentonite. One explanation for the adhesiveness of clays producing aluminum hydroxide gel is that they carry a positive charge—the leaf is negative.

Another explanation may be that certain materials combine with the waxy coatings on apples and apple leaves. Such materials would obviously stick better than those that do not react in this way.

The positive answer is not yet known and we must probe deeper into chemistry and physics to find it. Why some stickers stick better than others may be of only academic interest to the grower, but this answer is a step towards uncovering new and better stickers to protect his trees and other crops from pests—and in this he is most immediately interested.

[1] Dr. Garman is an entomologist.

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Bulletins

517. Pole Rot of Tobacco.
518. Hybrid Sweet Corn.
519. The Connecticut Charcoal Kiln.
520. Mite Species from Apple Trees in Connecticut.
521. Toxicity of Nicotine, Nicotinium Salts and Related Compounds by Injection.
522. Commercial Feeding Stuffs. Report on Inspection, 1947.
523. The Forest Soils of Connecticut.
524. Toxicity of DDT Residues: Effect of Time of Exposure of Insects, Coverage and Tenacity.
525. Commercial Fertilizers. Report for 1948.
526. Crop Residues as Causative Agents of Root Rots of Vegetables.
527. Controlling Diseases of Tobacco.

Circulars

165. Sweet Dent Silage.
166. Control of the Japanese Beetle.
167. Control of Insects on Tobacco.

Special Bulletins

Saving Your Valued Elms.
Combating the Dutch Elm Disease.

NEW LETTUCE DISEASE GAINS PROMINENCE

by Saul Rich [1]

For the past few years, Connecticut growers of early planted lettuce have sustained serious losses because their crop failed to mature in time for the high priced early market. The plants would do well for a while, but about a month after coming up or being set out they would stop developing and remain at a standstill. With the coming of warmer weather, the plants would again begin to grow, but by this time the crop would have been set back enough so that it would miss the early market.

Weather Blamed

Most growers blamed "unusual weather" for their troubles, until the situation was brought to the attention of the Experiment Station in 1946. Dr. Horsfall, who made the investigation, suspected that the lettuce was actually suffering from a virus disease first described in California in 1934 as "big vein".

In January, 1949, his diagnosis was supported by experimental transmission of the disease in our greenhouse. Big vein infected plants are stunted and show abnormally large, clear veins, from which the disease gets its name.

Research workers in the California Agricultural Experiment Station and in the United States Department of Agriculture have uncovered the following fundamental information about lettuce big vein: (1) The disease is caused by a soil-borne virus which can survive in lettuce-free soil for at least eight years. (2) The disease may be carried by a lettuce root-aphid, but an insect is not required for the plant to pick up the disease from infected soil. (3) Healthy plants can pick up the disease only through their roots. (4) The severity of symptoms is favored by cool temperatures and excess soil moisture, and infected plants have a good chance for maturing normally when air temperatures are above 60°F. and soil moisture is not excessive. (5) Big vein infected soil can be made safe for lettuce by soil fumigation with formaldehyde or chloropicrin, or by heating with steam to 145°F. for 30 minutes.

The problem of eradicating big vein from diseased fields is definitely *not* solved because of two factors: (1) the soil sterilizing methods mentioned above are much too expensive for practical field use; and (2) the means of initial infection is unknown so that there is no way of insuring that the fields will not become reinfected immediately after sterilization. This fall, we are planning to apply various chemicals to infected soil in search of a practical control method.

Control Steps

Until such information is available, growers of early-market lettuce can do two things to fight big vein: (1) Plant on well-drained soil so that the soil moisture content will not be favorable for big vein symptom development. (2) Seed the lettuce rather than setting it out, because transplanting injures the roots and makes infection easier.

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[1] Dr. Rich is a plant pathologist.

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