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FRONTIERS of Plant Science

FALL ISSUE

CONNECTICUT AGRICULTURAL EXPERIMENT STATION, NEW HAVEN

SHOULD WE STOP *Cultivating?*

by C. L. W. Swanson[1]

For many years, the farmer's primary purpose in drawing the cultivator over his fields has been weed control. Now, on some crops at least, he can kill weeds by newer, easier methods — chemicals, flame throwers and oil sprays. Where he can get good weed control by such means, should he continue to cultivate?

Here in the Soils Department we think that one advantage of no cultivation may be an improvement in the way a soil holds itself together—the structure of the soil. Soils with good soil structure are those that are loose, open and porous, with lots of places for air and water to get into the soil easily. Other soils are tight and compact, and have few large air spaces in them. These soils have poor soil structure.

We know that weight and vibration of heavy machines, particularly tractors, pack the soil and help break down soil structure. If we can cut down on cultivation, soil structure should improve since we won't have to run over the ground so many times with heavy machinery.

Cultivation on light soils also results in the loss of soil organic matter by over-stimulating the soil microorganisms which feed upon it, thus decreasing the supply.

To see whether or not the elimination of cultivation by the use of new methods of weed control will actually benefit soil structure, the Soils Department began a new experiment at the Mount Carmel Farm this summer. Corn and carrot plots were set up on a Cheshire loam soil. On some plots, weeds were controlled by cultivation; on others, the newer weed control methods were used. 2,4-D[2] and flame control[3] were the new methods used on the corn plots, while carrots were treated with oil sprays.[4] All plots were given equivalent fertilization.

Unexpected Results

Unusual weather during the growing season gave us unexpected results. In May, we had almost twice as much rain as the average for that month while April and June rains were also well above the normal. In contrast, the months of July and August were unusually dry.

The result was indirect injury to the corn in the 2,4-D plots. The heavy rains that fell packed the ground and, combined with the hot, dry weather that followed, formed a hard crust on the soil surface. This crust did not allow free circulation of air into the soil, and resulted in a decrease in the production of nitrates by soil organisms. The corn showed definite nitrogen deficiency in contrast to the dark green color of the cultivated corn. The flamed corn was also a lighter green in color than the cultivated corn, suggesting less available nitrogen.

These differences did not show up at first. When the corn was 8-10 inches tall, growth of all corn was about the same and all of it had a good green color.

In September, however, the cultivated corn looked much better in all respects than either the flame cultivated or 2,4-D treated plots. Besides being a darker green color, the stalks were thicker and the ears larger and more numerous than on the other plots. The cultivated corn grew vigorously throughout the season and, from visual observation, will produce the largest yield with the flamed corn next, followed by the 2,4-D treated corn.

Weed control results, though of only secondary interest in this experiment, were interesting. The cultivated plots were practically weed-free throughout the season. For the first month after planting, there were few weeds in the 2,4-D treated plots. A few broad-leafed varieties started coming in with the grass weeds during August. A second application of 2,4-D, 45 days after planting, did an excellent job of killing the broadleaf weeds but the grass weeds were not affected. Flaming kept the weeds down initially but did not kill all of the weeds.

Carrots Vary Less

Much less difference in results showed up on the carrot plots. In the early part of the season, the cultivated carrots looked best. They were more vigorous and somewhat larger in size. By September, however, there was no noticeable difference in size

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[1] Dr. Swanson is head of the Station's Soils Department.

[2] 1½ pounds sodium salt of 2,4-D per acre, pre-emergence spray.

[3] Also cultivated last cultivation.

[4] 75-80 gallons of oil spray per acre.

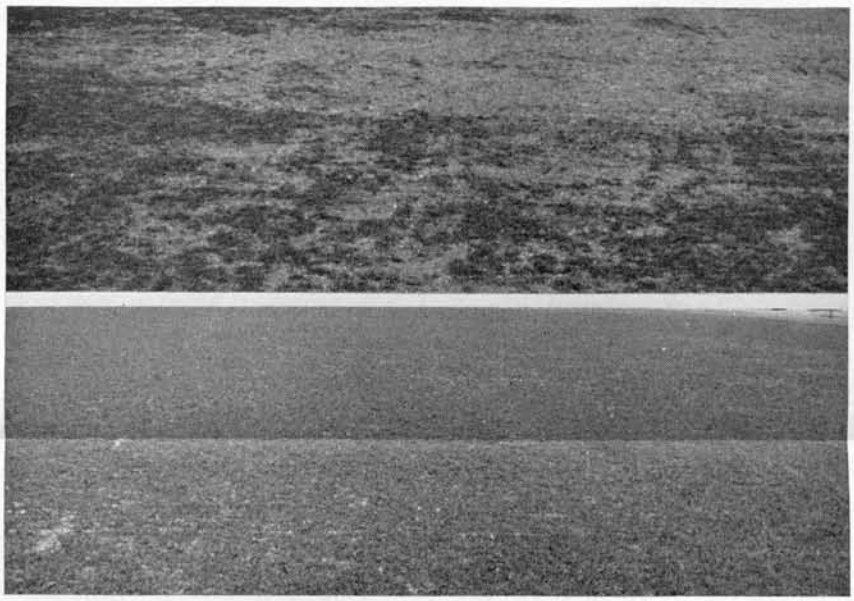
Some years, we need to cultivate. Heavy rains early in the 1948 season packed the soil on the uncultivated corn plots at right where 2,4-D was used, and corn is lighter in color, smaller, and less vigorous than on the cultivated plots at left.

Science Discovers Some New Tools For Lawn Insect Control

by John C. Schread[1]

Among the worst upsetters of the green color scheme with which homeowners like to surround their dwellings are lawn insects. Let these invaders, of which there is a wide variety, get in some "good" work and the even green carpet which we want our lawns to resemble begins to look more like a tattered brown-patterned rug.

Six of the most serious of these pests are the Japanese beetle, chinch bugs, cutworms, sod webworms, leafhoppers and the cornfield ant. The lawn havoc which follows in the wake of the Jap beetle, sod webworms and cutworms is caused by the larvae which hatch from eggs in the turf and immediately start feeding on the grass roots. The result is brown, dead patches in the lawn, sometimes even complete destruction of the sod. Chinch bugs and leafhoppers suck juices from the grass during both their immature and adult stages, causing discoloration and a dried out appearance of the turf.



Lethal weapon against Jap beetle grubs and several other lawn insects, Chlordane used on turf results in a smooth, green area like that shown in the lower picture. Turf in the upper photograph was on an adjacent plot and was untreated.

Adults of the cornfield ant cause damage by building their nests in turf. Bad enough in itself, but the ant erects a low mound over its dwelling place and, in a strong colony, small, clustered craters can be seen scattered over the entire area. In spots where these craters appear, grass is destroyed.

Homeowners have made use of several tools for fighting these pests. For years, lead arsenate has been used for control of such insects as the Jap beetle, sod webworms and cutworms; tobacco dust has been used against the chinch bug, and a number of ant remedies have been on the market. Lead arsenate had the drawback, though, of being slow-acting and was sometimes difficult to use, while neither tobacco dust nor any of the ant poisons could be called a really satisfactory control.

With the advent of two new insecticides, however, homeowners at last seem to have controls that are fast, effective and give lasting protection. These two materials are DDT and Chlordane. In 1946, the Connecticut Station initiated testing of these against lawn insects when it started a series of Jap beetle control experiments using DDT. Our Entomology Department found that 10 per cent DDT dust applied at the rate of 250 pounds to the acre gave excellent control of beetle grubs, far above results from comparative tests using lead arsenate. Moreover, our tests showed, DDT applications did not have to be made every year; some reports say that residual protection lasts up to five years.

Newer still is Chlordane, which seems to have some advantages over even the very successful DDT for Jap beetle control. We have been impressed most with its fast action—news indeed to the homeowner who discovers a grub infestation in late spring and must get quick results if he's to have a decent-looking lawn by summertime. In our tests, 5 per cent Chlordane dust, applied at the rate of 200 pounds per acre, cleared up heavy grub infestations within two weeks. Its lasting powers look good, too. Inspection this fall of plots treated in the spring of 1947 revealed that the original applications of Chlordane were still giving 100 per cent control of the third generation of beetle grubs.

On chinch bugs, one of the most difficult-to-control lawn pests, results this year were startling. On heavily infested turf, we applied Chlordane at the rate of 5 pounds of 5 per cent dust per 1,000 square feet. Twenty hours later, the infestation was wiped out and residual effects gave protection for the next eight weeks. Rain did not seem to interfere with Chlordane protection, one of the chief drawbacks to tobacco dusts, which were easily washed off.

Chlordane also looks good for control of the sod webworm and cutworms. In our experiments, 5 ounces of 50 per cent wettable powder in 3 or 4 gallons of water per 1,000 square feet gave most effective control of the sod webworm, while cutworms seemed to be best controlled when the water gallonage was cut down to two gallons, using the same amount of insecticide.

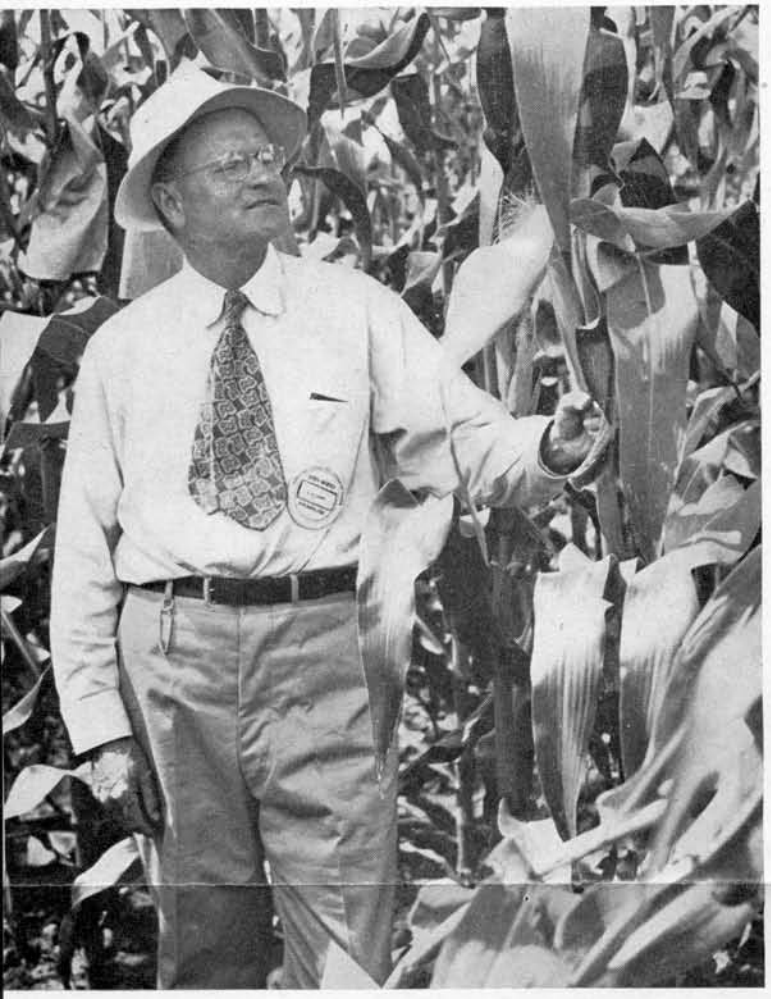
The cornfield ant damages lawns by building small, cratered nests like this one.

After two years of

(Continued on page 8)

[1] Mr. Schread is an entomologist.

Connecticut Points With Pride



Originator of the first practical method of producing hybrid corn, Dr. Donald F. Jones stands with some of the modern hybrids which have stemmed from his discovery.

OUR COVER PICTURE for this, the first, issue of "Frontiers of Plant Science" shows a corn harvesting scene. For Volume I, Number 1 of a journal from the Connecticut Agricultural Experiment Station, this seems peculiarly appropriate. For the thing for which the Connecticut Station is perhaps best known is hybrid corn and this year marks the 30th anniversary of the introduction of our first hybrid.

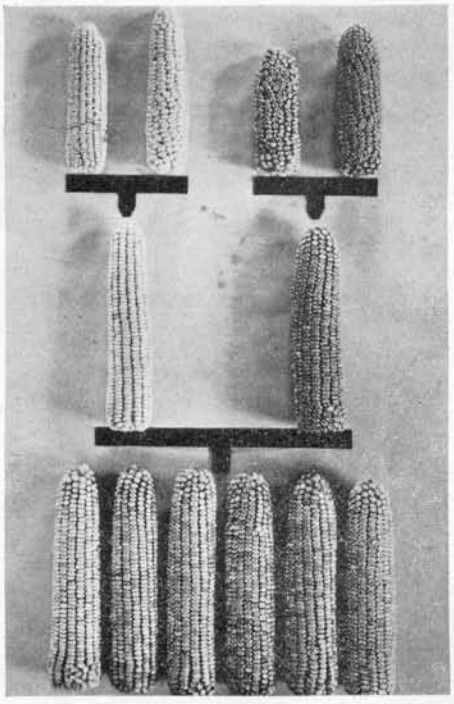
It was in 1918 that Dr. Donald F. Jones, only three years after he had joined the Station staff, produced a "double crossed" corn which he called Burr-Leaming. From this small beginning 30 years ago has sprung today's huge hybrid corn industry, which has improved immeasurably America's No. 1 crop and added at least three-quarter billion dollars annually to the income of the nation's farmers.

Hybrids Before

Dr. Jones' Burr-Leaming was not the first hybrid corn produced. Such pioneers as Dr. George H. Shull of Carnegie Institute and Dr. E. M. East of the Connecticut Station had discovered the amazing effect of crossing two inbred strains of corn at least 10 years before Dr. Jones did his early work. The hybrids resulting from such crosses were much taller, more vigorous, and gave greatly higher yields than their parents. However, these discoveries seemed to have little immediate practical value. The small weak inbred ears were too expensive and unproductive to serve as a seed source for farmers' large corn crops.

When Dr. Jones first began breeding corn, it seemed to him that perhaps these early workers had not gone far enough. He wondered what would happen if two of the strong, productive first generation hybrids were crossed with each other. Would the "hybrid vigor" effect be retained into the second generation? He first put his ideas to the practical test in 1917, when he made such a cross. The next year, when he grew his new second generation hybrids, his ideas were immediately proved correct. There was no diminishing in hybrid vigor from the second crossing and the resultant plants were as high in yields and quality as their parents. The real significance of all this was, of course, that now a plentiful, economical seed supply was available in the form of the first generation parents, and the farmer could make use of the increased vigor, yields and strength of hybrids.

Uniformity was also an important characteristic of the new hybrids. This did not come from the hybrid vigor effect but from the inbred corn itself, which was the starting point from which the hybrids were made. Years of careful selection and selfing (breeding a plant to itself) resulted in inbred plants that were remarkably like each other in size, shape, quality and general performance. These were totally unlike the old open-pollinated corn which farmers had grown for generations. In those days, seed was saved each year for the next season's crop. Fields where this seed was grown were almost invariably within pollinating distance of other fields and ears saved for seed might have a rather varied parentage. The resulting crop was apt to be an odd mixture of tall, short, spindly, vigorous, good and poor-yielding plants.



Double crossing for better corn. Four inbred ears at top are crossed to get 1st generation hybrids in second row. Crossed again, these give 2nd generation hybrids, the final product.

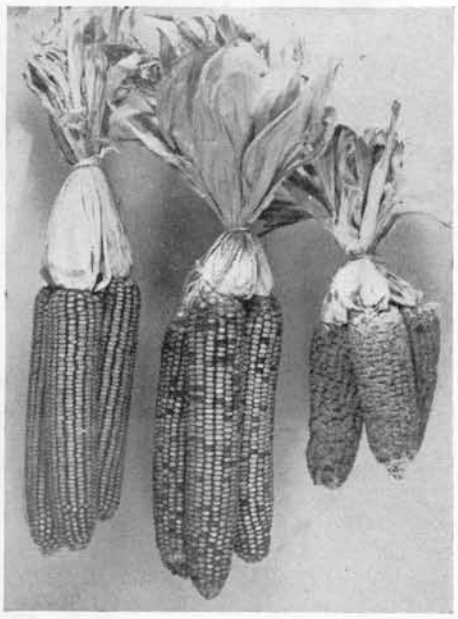
Now, with the combined effects of inbreeding to insure uniformity and hybridization to promote strength and vigor, the farmer could be reasonably sure in advance that his corn crop would give a consistently superior performance.

Widespread use by growers of the new hybrids did not, of course, take place overnight. It took years of intensive inbreeding and crossing by

to Thirty Years of Hybrid Corn

scientists all over the country to produce top-quality, high-yielding hybrids for all sections where corn was grown. Once this was done, however, hybrid corn made amazingly rapid strides.

In 1933, only one acre out of each 1,000 planted to corn was hybrid; by 1939, this had grown to one out of every four; in 1943, it was one out of two, and in the period, 1937 to 1944, there was an increase in hybrids of nearly seven million acres each year. Since that time, the increase has been smaller but only because the use of hybrids in the principal corn-growing areas is fast approaching the 100 per cent mark. Today, more than 60 million acres of hybrid corn are grown annually in this country alone and other nations are making comparable use of it.



Sweet dent hybrids are one of the Connecticut Station's recent developments in corn breeding. A combination of field and sweet corn, sweet dents make good cattle feed, the sweet corn content giving them increased palatability. Ears in the center show one of the most promising of these new varieties. Note large size of ears, a factor in producing the high yields of sweet dent corn.

More Corn On Less Land

The primary reason why farmers were so quick to accept hybrid corn was that it meant more corn and better corn on less land. Moreover, the higher yields per acre and superior performance of the hybrids were strikingly uniform and dependable. These were advantages right from the beginning.

Today, corn is almost tailormade to suit the farmer's needs. By selection of superior inbred strains, scientists have produced hybrids that possess such special qualities as drought resistance, ability to withstand storms, high protein content, and resistance to disease and insect attack.

All of this work stems from Dr. Jones' original discovery and these many modern improvements would have been impossible without his pioneer work. Since those early days, the Connecticut Station Genetics Department, under his direction, has retained its high place in hybrid corn work.

Work Continues

Basic genetics investigations have been carried on continuously which have been utilized by corn breeders here and elsewhere for the production of better hybrids. Discoveries of immediate practical value have also been numerous. Geneticists in the department have developed several varieties of field corn to fit the special needs of growers in this area. Our cover picture shows one of the most recent of these, Connecticut 830, voted the outstanding hybrid of the year in 1947 regional trials. A late grain and ensilage variety, C830 is notable for its large stalk growth and good ear development. Tests have also shown it to possess good standing ability and freedom from stalk breakage.

In the sweet corn field, too, Connecticut has long been a leader, the Station having produced a greater number of successful sweet corn hybrids than any other institution. Among the better known Connecticut sweet corn varieties are Marcross, Carmelcross, Lincoln and Lee. The Genetics Department is also responsible for developing a series of sweet corn hybrids which, planted all on the same date, mature at intervals. By their use, sweet corn throughout the season is assured without the necessity of several plantings.

Connecticut 520, a new early-maturing grain corn hybrid, developed by Dr. Jones and his associates at the Connecticut Station. It's outstanding for its high yields of good quality corn and also for its low stalk breakage.

From the Director

We at the Connecticut Agricultural Station embark herewith on a new venture—a new journal. I should like to tell you some of our reasons for starting this venture and some of our hopes for its future.

Seventy-three years ago the people of Connecticut also embarked on a new venture when they put us in business. At that time, there was no institution like ours in America and only one or two of its kind in the whole world.

That venture eminently succeeded. Agricultural experiment stations now exist in every state and territory in the United States and some states have as many as five.

In our charter, the people, through the General Assembly, said to us: "Put science to work for agriculture and tell us your findings." My story here is not concerned with our past contributions to agriculture, to gardening and to nutrition. They speak for themselves. It is concerned with our instructions to tell you about our findings.

From the beginning, we have tried to do this but, too often, our reports have contained so much statistical material and technical detail that our real story was lost to you.

In "Frontiers of Plant Science", we shall eliminate all ponderous detail and try to present our story in such a way that its meaning will be immediately apparent.

We shall draw on all the many sources at our command to give you up-to-the-minute information on the "Frontiers of Plant Science" and a lot of the area behind the frontiers. Many of our friends tell us that they are interested in how science performs as well as in what it has done to lessen their loads. We shall not forget this aspect in telling our story.

Neither shall we fail to indicate how plant science can be used to make a more efficient agriculture, more efficient gardening, and a more pleasant living.

We offer you a new journal. We hope you like it.

J. G. Horsfall

NEW INSECT CAUSES APPLE DAMAGE

by Philip Garman[1]

Oriental imports in the insect pest category seem, unfortunately, to be none too rare. Now, again, a new one has put in an appearance in Connecticut. Identified here for the first time last summer, this is the Japanese leafhopper or, as it is known in entomological circles, *Orientus ishidae* Matsumura.

The presence of the pest in this State was first called to our attention in August by Mr. S. L. Root of Farmington, whose apple orchard evidenced an unusual type of leaf injury. A large portion of the foliage on some of his trees looked as if it had been severely burned by sprays. Upon examination of individual leaves, a number of leafhopper skins were found in almost every case and there was little doubt that a hopper of some sort was to blame. Laboratory examination soon revealed the particular species.

Since the original infestation was discovered, the Japanese leafhopper has also been found in Branford and New Haven, and is probably distributed over the entire State. We think, too, that it has undoubtedly been present in previous seasons but that the damage was slight and was attributed to other causes.

Known in U. S. Before

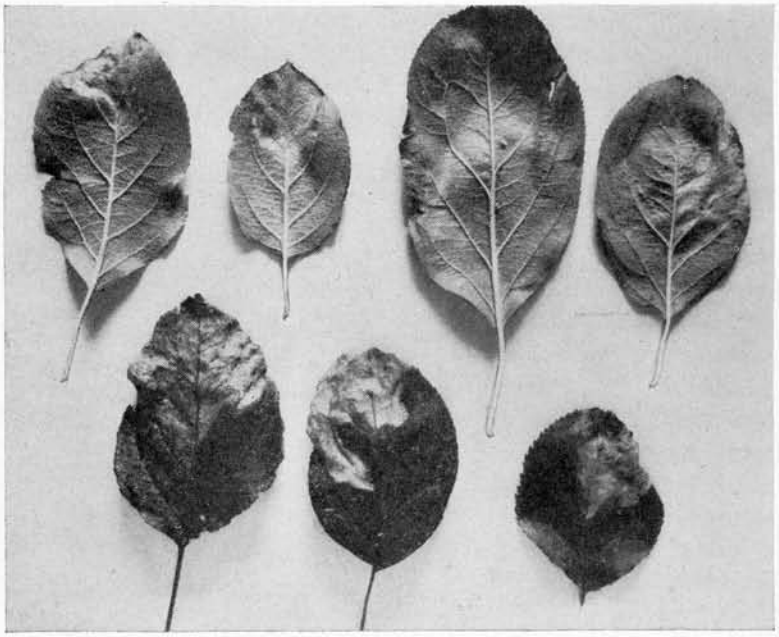
It is no stranger to the northeastern United States, although Connecticut growers have not been seriously troubled with it before. First reported in New Jersey in 1919, it is now known to occur in New York, Pennsylvania, Maryland and New Hampshire and is probably present in other eastern states as well.

Growers suspecting Japanese leafhoppers as the cause of apple foliage injury should have little trouble in identifying the pest. Much larger than the common white apple leafhopper, it is about 1/5 inch in length. At first glance, it appears to be dark gray in color, but on closer scrutiny, the wings are seen to be milky with brownish veins. The legs are black. Nymphs of the pest are brown with white spots.

Entomologists believe that the pest was first brought to this country in the egg stage on Aralia plants. Very little is known about its life history but, from the fact that it appears to have been imported in the egg stage, the assumption is that it passes the winter as an egg in bark. Thus far, the known host plants are Aralia, hazel and apple. We believe that there is only one generation a year.

From preliminary tests, the Japanese leafhopper seems to be easily controlled with sprays of either DDT or parathion.

[1] Dr. Garman is entomologist in charge of fruit investigations.



Leaves damaged by the Japanese leafhopper, a new apple pest in Connecticut, look like these. Foliage injured by the insect has much the same appearance as severe spray burn.

Blame for Baffling Tobacco Disease Laid to *Nematodes*

by Paul J. Anderson[1]

Brown rootrot, now believed to be caused by nematodes, makes tobacco look like this. Note contrast with normal tobacco in background.

Signs of disease in any crop field are portents of trouble to come to the grower, no matter whether his crop be potatoes, truck vegetables or tobacco. But probably no group of growers experiences more dismay when such signs appear than do the tobacco men, whose stake in their crops is at the top. For tobacco is Connecticut's most expensive crop and the loss of even a small portion of his annual production means heavy losses to the grower. Among the disease symptoms which he greets with most dismay are those of brown rootrot, that stunter of tobacco which can strike large areas of tobacco fields and render the crop valueless.

Resists Control

Fortunately, we have learned how to control most diseases of tobacco. Wildfire, black rootrot and mildew, all serious problems in their time, have now yielded, at least in large part, to the findings of science. But brown rootrot has caused heavy annual losses in the tobacco fields for many years and has stubbornly resisted all attempts at effective control. Now, at last, it looks as if we may have found an answer.

First, however, a clear distinction should be made between black and brown rootrot. Both affect tobacco in the same way: in an infected field, patches of various sizes appear in which the tobacco fails to make sufficient growth to be worth harvesting at the end of the season. No amount of fertilizer, cultivation or irrigation will make these stunted areas produce a crop. When the roots of such plants are washed and examined, they are not white like those of a healthy plant but are mostly brown or black. Moreover, the root system does not spread extensively through the soil but consists largely of a "brush" of short discolored fibers at the bottom with possibly a few normal roots near the surface of the soil.

Look at the Roots

If some of the roots or parts of them are coal black, the disease is black rootrot, for which we know the cause and cure. Black rootrot is caused by a parasitic fungus (*Thielaviopsis basicola*) and can be controlled by keeping the soil fairly acid (below 5.6 pH) or by growing resistant varieties like Havana Seed 211 or the Connecticut 15 Shade variety.

On the other hand, years of research in this and other tobacco states, has not, until very recently, given us the answer to the baffling problem of brown rootrot. Although many theories have been advanced as to its cause, none has been supported by sufficient evidence. Moreover, no method of preventing or curing the disease resulted from these investigations.

Now, it looks as if the culprits causing the disease are parasitic nematodes, tiny eel-worms that puncture the roots of tobacco plants and live within the root tissues or on the root surface. The lesions made by these nematodes may furnish entryways for fungi or bacteria that complete the destruction of the roots. Absolute proof that nematodes are the primary cause of the type of brown rootrot found in Connecticut has not been produced, largely because no way has been found to grow the nematodes in pure culture and reproduce the disease under aseptic conditions. Nevertheless, all the peculiarities of the behavior of brown rootrot can be explained by the nematode hypothesis. During 1948 the disease was widespread here, and caused losses of hundreds of thousands of dollars, especially in the Shade fields. Many plants taken from such fields were examined microscopically and nematodes were almost always found, frequently of the meadow nematode (Pratylenchus) type which is said to be the cause of a similar trouble in the southern tobacco regions.

Experiments Successful

Control experiments were conducted by the Tobacco Laboratory staff and by several Shade tobacco growers. Nematacidal fumigants were applied to the soil before the crop was planted. The materials used were ethylene dibromide ("Iscobrome" and "Dowfume 40"), and a mixture of dichloropropene and dichloropropane ("D-D"). In most of the tests, the results were spectacularly successful, treated plots producing normal, healthy growth, while adjacent untreated plots were not worth harvesting. Failure of some of the Shade growers to get good control may have been due to the fact that on some fields the poor growth was not due to nematodes but to other undetermined causes. All growth failures in tobacco fields are not due to brown rootrot and the grower can easily make a mistake in diagnosis.

When brown rootrot is definitely the disease, however, the answer seems to be — control the nematodes and you'll take care of the disease problem.

Soil fumigation looks good for controlling brown rootrot. Soil in foreground is untreated, while ethylene dibromide was applied to that in background.

[1] Dr. Anderson is head of the Tobacco Laboratory at Windsor.

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Should We Stop Cultivating?

(Continued from page 2)

and growth. It was necessary to spot spray the oil-treated plots several times to kill the weeds which came up or were missed. In general, the oil spray controlled the weeds very satisfactorily.

Preliminary measurements of the soil structure on all of the plots have been made. The experiment was planned so that with each cultivation the rear tractor wheel ran over the same ground. Samples were taken in the area travelled by the wheel and from untravelled areas. From the data obtained, it appears that running a tractor over the ground three times during the season has no appreciable destructive effect on the structure of the soil. There is some evidence, however, that previous cultivation and use of heavy machinery has produced a tighter, heavier and more dense soil at the 4 to 6 inch depth than at the 0-2 or 6-8 inch depths.

It is not expected that one year's results will show up the effects of cultivation versus non-cultivation. There is reason to believe, however, that after several years, the cultivated area will have poorer structure than the non-cultivated area. In the Connecticut Valley, soil structure samples were taken this summer at a 0-2 inch depth in a field cropped to potatoes continuously for ten years. The soil was a Hartford fine sandy loam. Samples were taken on the potato row itself, and in the area between the rows travelled by the rear tractor wheel. The soil in the rear-wheel tractor area was 17 per cent heavier than the soil in the potato row. In this field, the tractor was run over the land about a dozen times in the operations of cultivating and spraying the potatoes.

Although we do not have the answer yet on whether cultivation is absolutely necessary, this year's data point up the fact that cultivation is beneficial under certain conditions. At least one such condition is in seasons of abnormally high and hard rainfall. Breaking up the crust left by these rains will aerate the soil, providing oxygen for soil organisms so that nitrates can be produced for the plants.

Cultivators Still Needed

So it looks as if we can't yet relegate our mechanical cultivators to the museum. Judicious combining of newer weed control methods with cultivation, the proportions of each depending upon specific conditions of the season and the field in question, seems to be the best answer. The result should be better soil structure and that means stronger, healthier, and more productive plants.

New Controls For Lawn Insects

(Continued from page 3)

trial, we feel we are safe in saying that Chlordane is the best material yet discovered for control of the cornfield ant. It gives almost immediate 100 per cent control and four to six weeks protection from reinfestation. We first applied Chlordane for this purpose to fine turf in 1947; the rate of 4 ounces of 50 per cent wettable powder in 75-100 gallons of water per 1,000 square feet being the most successful minimum dosage. From this initial application, we had 100 per cent control up to July 1, 1948. After that, a minimum of 50 per cent wettable powder at the rate of 1 to 2 ounces per 1,000 square feet gave complete freedom from ants for the rest of the season. Beginning July 1, three treatments in all were made, at three week intervals.

Chlordane treatments were also successful when applied in small dosages to the individual ant hills. One-eighth of a teaspoonful of Chlordane, 50 per cent wettable powder, placed in the center of each crater and thoroughly watered into the nest gave excellent control. A small pressure sprayer, with the spreader removed from the nozzle, may be used for watering. Water slowly poured from a watering can, with the sprinkler removed, is another efficient method.

DDT seems to be best for control of leafhoppers, 50 per cent wettable powder at the rate of 5 tablespoons in 5 gallons of water per 1,000 square feet having given good control in our tests.

If Jap beetles, chinch bugs, cutworms, sod webworms, leafhoppers and cornfield ants can be eliminated from our lawns, at least half the battle for a good-looking turf will be won. It appears that DDT and Chlordane can do just this job.

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