Control
Peppermint Diseases

STATION BULLETIN 547
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February 1955
Control Peppermint Diseases

A Guide for Recognizing and Controlling Peppermint Diseases

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FIGURE 1. Below are OSC test plots which show differences of rust resistance among mint varieties.
Peppermint has been grown in Oregon for essential oil production for about 45 years. Since 1940 the industry has expanded rapidly, and it now comprises an important agricultural enterprise in the Willamette Valley and lower Columbia River areas of the state. Smaller acreages are established in Klamath, Malheur, and Umatilla Counties. In 1953, approximately 14,000 acres were planted to peppermint in Oregon.

Commercial culture of the peppermint variety now grown in Oregon originated near Mitcham, in Surrey County, England about 1750. The English peppermint variety was introduced into the United States about 1883, and is commonly called “Mitcham” or “Black Mitcham” mint. Planting stock of the Mitcham variety was brought to Oregon from Michigan about 1909. The Mitcham variety of peppermint is male sterile and rarely produces seed. Propagation is by means of abundantly produced underground rhizomes and aboveground stolons, both commonly called “roots.”

Disease losses reported in 1948

No serious disease losses on peppermint were reported in Oregon prior to 1948. In that year, rust was found in Columbia County near Clatskanie. Economic losses occurred in some peppermint fields in Columbia County during the summer of 1949, and by November every mint field in the county was infested with rust. Mint rust appeared in Willamette Valley peppermint plantings in the spring of 1950, and by November every mint field examined in western Oregon was infested.

Verticillium wilt of peppermint has caused great losses in Michigan and Indiana since 1924, but was not found in Oregon until 1944. Losses from wilt have not yet become serious in Oregon, but in view of the destruction caused by wilt in the Midwest, its presence in Oregon poses a threat.

Continuous culture of peppermint on the same soil for many years has contributed to the increase of plant parasitic nematodes (tiny, slender worms) and fungi that cause root rots. These organisms have already caused considerable damage and, unless cultural practices are modified, damage may be expected to become increasingly serious.

Peppermint is sometimes attacked by powdery mildew, a fungus stem rot, and a fungus leaf spot, but these diseases have not caused serious losses in Oregon.

Research began in 1949

In 1949 and 1950 Mr. A. P. Steenland, then Extension Plant Pathologist, conducted preliminary investigations on peppermint rust control. The Oregon Agricultural Experiment Station initiated a project on control of mint diseases in 1951. This project has been aided financially by a grant from the Beech-Nut Packing Company of Canajoharie, New York. Pertinent results of experiments on peppermint diseases and their control are presented in this bulletin.
Rust of peppermint is caused by a fungus (*Puccinia menthae* Pers.) which lives and reproduces only on plants of the mint family. Mint rust was first found on a species of mint in Europe in 1801, and is now known to be distributed widely throughout the world. This rust was found on wild mint in Washington as early as 1885. It was discovered in commercial peppermint plantings in Columbia County, Oregon, in 1948. Later, rust was observed on peppermint in Ontario, Canada, in 1950, and in Michigan in 1951. Since the rust of wild mint in Oregon can infect commercial peppermint, it is likely that the recent outbreak of the disease in commercial plantings originated by spread of the fungus from wild to cultivated mint.

**Peppermint rusts different**

Rust on spearmint has been a seasonally important disease in Michigan and Indiana for many years. Rust did not affect peppermint in the Midwest, however, even when peppermint was grown adjacent to heavily rust-infected spearmint. When a comparison was made of rusts from spearmint and peppermint, it was found that rust from common spearmint could not infect peppermint, and that rust from peppermint could not infect common spearmint. Both the peppermint and spearmint races of mint rust can infect Scotch spearmint, which is a different species from common spearmint, although it produces spearmint oil. Thus, spearmint and peppermint rusts are two distinct races. Thirteen other races of mint rust have been found on plants in the mint family by scientists at Purdue University.

**Life history**

Mint rust fungus reproduces by means of spores. Spores are microscopic bodies comparable to plant seeds, in that under suitable conditions they germinate and give rise to new individuals. Mint rust produces five different kinds of spores, each at different times of its life cycle during one year. All five of the different spore forms must be produced for the fungus to live from one year to the next.

The life cycle of the mint rust fungus in Oregon has been studied and is now well known. A diagram of the life cycle is shown on the back cover. Beginning in the fall, usually in late October or early November, masses of black colored spores are produced on mint leaves, stems, and aboveground runners, as shown in part 1 of the life cycle diagram. These black spores have a thick protective covering which enables them to withstand adverse weather conditions such as wetting, freezing, and drying. The black spores are the overwintering stage of the fungus, and it is only by means of these spores that mint rust survives through the winter in Oregon. The greatest source of black spores is on the after-harvest regrowth.

After a short period of dormancy, black spores germinate when given favorable conditions of moisture and temperature. Black spores produced during November on peppermint leaves in fields in the Willamette Valley germinated best during January, but many were still alive during March, more than 100 days after they were produced.

When black spores germinate, a slender tube develops from the parent
spore. On this tube four tiny, colorless, thin-walled spores are produced as shown in part 2 of the life cycle diagram. These colorless spores are able to infect young stems or leaves of peppermint plants. A few days after infection of young mint plants by colorless spores, a small red blister begins to develop around the point of each infection. The red blisters gradually enlarge, and on them, the fungus produces tiny flask-shaped structures containing sexual spores. The red blister stage of mint rust is shown in part 3 of the life cycle diagram, and occurs on peppermint in Oregon from January to May.

From several days to several weeks after cross-fertilization by sexual spores, the red blisters break open and release thousands of brown spores as shown in part 5 of the life cycle diagram. Brown spores are carried by wind, insects, or splashing water to other leaves and other plants. One brown spore may infect a leaf and produce more than 10,000 more brown spores 2 weeks later. Infection, reproduction, and spread of brown spores continues throughout the spring and summer as shown in part 6 of the life cycle diagram, and may continue on the after-harvest regrowth until November. The brown summer spore stage is the most destructive to the crop.

**Symptoms and effects**

To recognize mint rust, only 3 of the 5 spore stages of the fungus are important. These are the yellow, the brown, and the black spore stages, each of which appears on mint plants at different times of the year.

The yellow spore stage occurs on stems or leaves of young mint shoots from late February to late May. Mint shoots infected with the yellow spore stage are frequently twisted, distorted, and easily broken at the point of infection. Figure 2 shows several young mint shoots with typical symptoms of the yellow spore stage. Many mint shoots infected with the yellow spore stage do not survive to maturity.

The brown spore stage occurs mostly on the undersides of mint leaves and less frequently on stems from May to November. Brown spores are produced in distinct brown spots which may become numerous on the undersides of leaves. Each brown spot is composed of thousands of tiny spores which have broken

![FIGURE 2. Yellow spore stage on young shoots.](image-url)
through the covering on the leaf surface. The appearance of the brown spore stage of mint rust is shown in Figure 3.

When the brown spore masses break through the leaf surface, oil-bearing glands on that portion of the leaf are destroyed. Since 99 per cent of the oil glands are on the leaves, the formation of the brown spore stage causes serious losses of oil. Figure 5 shows the destruction of oil glands on mint leaves with different degrees of rust. In addition, water is lost rapidly through the holes made in the leaf surface by the rust spots. When the water content of the leaf falls below a critical point, the leaves shrivel and drop from the plant. When peppermint plants are infected with the brown spore stage early in their development, production of lateral branches is greatly retarded as shown in Figure 4. The number of rhizomes and runners produced by heavily rust-infected plants is about one-third less than the number produced by healthy plants.

The black spore stage appears on leaves, stems, and aboveground runners during late October and November. It is identical in appearance to the brown spore stage except for the color of the spores. When black spore masses break through the surface of runners, the wound thus created frequently becomes infected with rot-causing fungi which may kill the runners.

**Control**

Research work conducted by Oregon State College has demonstrated that losses from mint rust can be largely overcome by modification of present cultural and management practices. For areas where rust is unusually severe because of weather conditions favorable to the fungus, a dust or spray program has been developed.

**Cultural practices**

Clean plowing is by far the most important step in mint rust control. Overwintering spores of the rust fungus are on the stubble, regrowth, and the soil surfaces. When stubble and regrowth are thoroughly turned under by clean plowing, most of the sources of infection are eliminated. Mint shoots that grow through 3 or 4 inches
FIGURE 5. Gradual destruction of oil glands on plant leaf is shown here. Upper left, none; upper right, slight; lower left, moderate; and lower right, severe. Leaves magnified about 50 times.
of soil do not carry the fungus with them and will emerge rust-free. When spring plowing is practiced, some of the shoots are already infected. However, when such infected shoots are covered 3 or 4 inches by clean plowing, they emerge rust-free because the fungus does not move inside the plants more than 1 to 1½ inches. Special effort should be made to plow close to field edges to turn under all runners which have spread from the main part of the field.

Light cultivation as soon after plowing as weather and soil conditions permit covers many rust-infected shoots not turned under by the plow, and thus reduces the amount of rust that starts in the field. Frequent cultivation with finger-type or rotary hoe weeders when the mint is 3 to 8 inches high breaks off many of the brittle, infected shoots, killing them before rust spreads to other healthy plants.

Heavy nitrogen fertilization early in the spring favors rust buildup, by causing early development of dense foliage at a time when weather conditions are usually favorable for rust development. Later applications of nitrogen through the irrigation water in July were found to compensate for leaf drop, caused by rust, by stimulating secondary growth at a time when weather conditions are usually unfavorable for rust development.

Irrigation is necessary to grow good mint in the Willamette Valley. While irrigation may cause rust buildup, it was found to reduce leaf drop due to rust. Leaves remain on rust-infected mint much longer when adequate soil moisture is available. Experiments conducted by Oregon State College demonstrated that rust-infected peppermint grown under adequate soil moisture conditions lost 40 per cent less leaves than mint grown under low soil moisture conditions.

**Chemical control**

*Spray wild and escaped mint.* All wild and escaped mint in fence rows, ditch banks, and field edges should be sprayed in late April or May with contact weed-killer chemicals. Dinitro weed-killer in diesel or stove oil has proved satisfactory. This spray will kill all aboveground parts of the rust-infected mint before rust spreads to the fields.

In the summer, wild and escaped mint not killed by the spring application should be sprayed with 2,4-D or a mixture of 2,4-D and 2,4,5-T. Frequently, two sprays are necessary to achieve a complete kill.

*Spray spring sources of rust in the field.* Some areas in fields, such as back-furrows, dead-furrows, and headlands along permanent irrigation main lines and around power poles or wells, may have mint stubble that was not completely plowed under. Such areas should be sprayed with ½ quarts of dinitro weed-killer and 30 gallons of diesel oil in 70 gallons of water. This spray will "burn back" any infected mint but will not kill it. Apply the spray during April or May when the mint is 3 to 5 inches high. Best results will be obtained if spray is applied on a sunny day.

*Dust or spray the crop.* Growers should consider carefully the cost and expected return before starting a dusting or spraying program for rust control. If yield losses from rust are expected to be relatively light, for example 5 pounds of oil per acre, the increased yield from dusting would hardly cover the cost of the dust. If losses are expected to be heavy, for example 15 pounds of oil per acre,
dusting should result in an increased net return well above the cost of materials and application at present average prices for mint oil. Growers must decide, on the basis of losses in previous years, whether a dusting or spraying program would result in increased net returns for their particular fields.

During a period of 4 years, many chemicals have been tested as dusts or sprays for control of mint rust. Some materials were effective but produced undesirable residues or flavors in the mint oil. One material, Phygon, has consistently given good rust control when applications were carefully timed and thorough coverage was attained. When used as directed below, Phygon does not cause undesirable residues or flavors in mint oil, and its use has been approved by the major oil buyers and users in this country.

If a dust or spray program is to be followed, it must be started before rust becomes prevalent. On fall-plowed mint, dusting or spraying should start about the middle of May, and applications should be continued at not more than 14-day and preferably at 10-day intervals until 3 or 4 weeks before harvest. On spring-plowed mint, applications should start about the first of June and be continued at 10- to 14-day intervals until 3 or 4 weeks before harvest.

Phygon dust should contain 1 1/2 per cent active chemical and should be applied at the rate of 30 or 40 pounds of dust per acre. Lighter applications may be made while the mint is small, but when the foliage becomes heavier, 40 pounds of dust per acre are necessary to insure good coverage. Phygon spray should be mixed at the rate of 1 pound of Phygon per 100 gallons of water, and should be applied at the rate of 100 gallons or more per acre.

Thorough coverage of the foliage with dust or spray is absolutely essential for good rust control. In experimental tests dusting has resulted in better rust control than spraying, because better coverage of heavy foliage was obtained by dusting. Only dusters with sufficient air blast to force the dust throughout the foliage should be used. Sprayers with pressure of 100 pounds or more per square inch are required to obtain good coverage. Cone-type spray nozzles are better than flat spray types. If a boom-type sprayer is used, a push-bar should be attached ahead of and lower than the boom to bend the mint over ahead of the spray pattern. Nozzles should be directed forward and downward at about a 45 degree angle, so the spray pattern covers the undersides of the leaves as plants are tipped forward by the push-bar.

**Rust-resistant varieties**

Since 1951 Oregon State College has been cooperating with the U. S. Department of Agriculture on development of rust-resistant varieties of peppermint. From about 200 varieties tested, more than 30 different rust-resistant mint varieties have been selected for further testing. Oil from some of the rust-resistant varieties is very close in flavor to oil from commercial peppermint. It appears that a variety of rust-resistant mint, with oil equal in flavor to commercial peppermint and with high yielding ability, can be developed. Such variety testing and development takes several years to complete, but if successful will be the best means of rust control. The illustration on page 2 shows some rust-resistant mint varieties growing in test plots at Oregon State College.
Verticillium wilt of mint is caused by a fungus (*Verticillium albo-atrum* R. & B.) that lives in the soil and in the roots and stems of certain plants. Strains of Verticillium fungus are known to cause a wilt disease on about 200 kinds of plants other than mints. Wilt fungus infects mint through the roots and grows into the water conducting system of the plant, causing a partial blocking of the water supply. In addition, there is strong evidence that the fungus produces a poison which injures or kills the plant cells. This poison may be transported by the water conducting system to other parts of the plant not yet invaded by the fungus.

Verticillium wilt of peppermint was first reported from Michigan in 1926. In Oregon, wilt was first found in the Lake Labish area near Salem in 1944. A survey of approximately 9,000 acres of Oregon peppermint fields conducted by Oregon State College in 1952 revealed only two fields with the wilt disease outside the Lake Labish area. Since that time two more fields with the wilt disease have been found in the Willamette Valley.

Losses from wilt have not yet become serious in Oregon; however, the disease is slowly spreading and is potentially a serious problem unless measures are taken to prevent its spread.

**How to recognize**

The first symptoms of wilt disease on peppermint consist of yellowing, twisting, and curling of the upper leaves as shown in Figure 6. The distance between leaves on the stem becomes shortened, resulting in a bunching of the upper leaves, and the whole plant becomes stunted as shown in Figure 7. As the disease progresses, the lower leaves die and drop. Eventually the whole plant becomes defoliated and the aboveground parts may die. When infected stems are split open the water conducting tissue has a light brown to black discoloration, in contrast to the greenish-white color of healthy stems. The darkening is more pronounced at the point where leaves are attached to the stem.

Positive identification of wilt can be made only by isolating the causal fungus in the laboratory. Growers may send suspicious plants to the Plant Clinic at Oregon State College for positive diagnosis. Any plants sent should be wrapped in moist paper and boxed, and mailed immediately to prevent deterioration of the specimen.

**Control**

Once a field becomes infested with the wilt fungus, no economically feasible method of control is yet known.
Control of this disease in Oregon is still largely a matter of preventing its introduction into new fields and areas. The disease was spread throughout the mint areas of the Midwest by the transfer of diseased planting stock from one area to another.

When making new plantings, growers should use wilt-free planting stock. Fields from which planting stock is to be taken should be examined carefully for symptoms of the disease in the summer before harvest. Suspicious plants may be sent to Oregon State College for positive diagnosis. Planting stock of either peppermint or spearmint should not be brought into Oregon from the Midwest, as it is almost certain to carry the disease.

Portions of fields known to be infested with the wilt fungus should be taken out of mint production in order to prevent spread to the rest of the field or to other fields. Care should be taken to prevent the movement of machinery from infested fields to other fields or areas, since the fungus may be carried in soil or diseased plants adhering to the machinery. The best crops to grow on wilt-infested soil are pasture, sweet corn or field corn, cereals, grasses, beets, carrots, and dill. Tomatoes, potatoes, cane berries, strawberries, peaches, cherries, plums, and certain nursery stock should not be grown on wilt-infested soil since the disease also affects them.

**Nematodes and Root Rots**

Nematodes are very small thread-like worms, many of which live in the soil without damaging plants, while others attack various plants. Nematodes that attack plants have a hollow, spear-shaped organ in the head with which they pierce plant cells and feed on the cell contents. Three different species of nematodes have been found causing disease on peppermint in Oregon. The species causing the most damage to mint is large enough to be seen, while the other two cannot be seen without a magnifying lens or a microscope.

The most serious nematode disease of peppermint is caused by a species (Longidorus sylphus Thorne) which is very slender, white in appearance, and averages about one-fourth inch in length. This nematode feeds on the young roots of mint and several other species of plants. More than 10,000 of these nematodes have been collected from 1 pint of soil around a moderately diseased mint plant.

The other two nematodes that attack mint in Oregon are called root knot (Meloidogyne hapla Chitwood) and pin nematodes (Paratylenchus macrophallus Goodey). Root knot nematodes are not yet damaging peppermint plantings but should be watched for carefully, since they are capable of
causing a very destructive disease. All mint species and varieties tested thus far have been susceptible to root knot nematodes. Pin nematodes have been responsible for some damage to Oregon peppermint plantings. They attack roots at any time, and young shoots before emergence. More than 8,000 pin nematodes have been collected from 1 pint of soil from around a diseased mint plant.

Root rots of peppermint are caused by at least five different fungus organisms. These fungi generally attack roots, stolons, and rhizomes through wounds caused by nematodes, insects, mint rust, or machinery. In general they are not capable of attacking healthy, vigorous roots unless they are first wounded or broken. Plants attacked by nematodes are almost always damaged further by fungus root rot. Fungi causing mint root rot are most active during winter and early spring and cause the most damage to mint during those seasons.

**How to recognize**

Peppermint plants attacked by the nematode *Longidorus sylphus* are stunted and reddish in color. Figure 8 shows a comparison of an extremely stunted plant grown in nematode-infested soil and a healthy plant grown in clean soil. The small feeder roots are short and stubby or completely destroyed. Nematodes feeding on the roots cause the plant to produce numerous short feeder roots around the point of injury resulting in a “bunchy root” appearance. Nematode-damaged roots are soon invaded by root rot fungi causing them to darken and die. The general appearance of roots damaged by *Longidorus* nematodes is shown in Figure 9.

Peppermint plants attacked by root knot nematodes are unthrifty and stunted, but can be most easily recognized by the appearance of the roots. Root knot nematodes cause galls and enlarged areas to form on the roots. These galls and enlargements of the root tissue contain female nematodes and egg masses. In the advanced stages of the disease, infected roots die and disintegrate.
Pin nematodes cause yellowing and stunting of peppermint plants. The roots of diseased plants have dark lesions on the surface, and infected roots later turn brown and die.

Peppermint stolons and rhizomes infected with root rot have brown or black dead or dying areas which may increase in size until stolons, rhizomes, and roots are killed. Stolons and rhizomes weakened by rust or freezing are most susceptible to fungus attack. The general appearance of root rot is shown in Figure 10 in contrast with normal, healthy plants.

### Crops Resistant and Susceptible to the Longidorus Nematode

<table>
<thead>
<tr>
<th>Resistant</th>
<th>Moderately resistant</th>
<th>Susceptible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa</td>
<td>Barley</td>
<td>Crimson clover</td>
</tr>
<tr>
<td>Austrian field pea</td>
<td>Beans</td>
<td>Peppermint</td>
</tr>
<tr>
<td>Common ryegrass</td>
<td>Garden peas</td>
<td>Red beets</td>
</tr>
<tr>
<td>Common vetch</td>
<td>Birdsfoot trefoil</td>
<td>Red clover</td>
</tr>
<tr>
<td>Hairy vetch</td>
<td>Ladino clover</td>
<td>Spearmint</td>
</tr>
<tr>
<td>Sweet corn</td>
<td>Sub clover</td>
<td>Tomato</td>
</tr>
<tr>
<td>Tall fescue</td>
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**Control**

Both nematodes and root rot fungi increase rapidly in soil on which a susceptible crop is grown continuously. The common practice of continuous peppermint culture on the same soil for many years is probably largely responsible for the present damage caused by nematodes and root rot fungi. Planting resistant crops on disease-infested soil is the easiest and most practical method of control.

Many crop plants have been tested for resistance to the *Longidorus* nematode at Oregon State College. Those crops on which nematodes did not live and reproduce well are listed in the table above as resistant, while crops on which the nematodes were able to live and reproduce are listed as susceptible. The three crop plants most resistant were sweet corn, common vetch, and hairy vetch. All grasses tested were also quite resistant. Beans, garden peas, Ladino clover, sub clover, Birdsfoot trefoil, and barley were only moderately resistant.

Unless crop rotation becomes a standard practice, nematode and root rot diseases on mint will probably become more serious in Oregon. A desirable rotation would be mint 4 to 6 years followed by nematode-resistant crops for 3 years. Crop rotation is desirable from many standpoints other than disease control, such as insect and
weed control, and improving soil tilth and water-holding capacity.

Where root rot alone is severe, fall plowing has resulted in much better mint stands than spring plowing. In fall-plowed fields, a sufficient number of young shoots to insure a good stand become established before the parent stolon or rhizome is killed. In areas where fall plowing cannot be practiced because of danger from flood washing, plowing should begin in the spring as soon as danger from flooding is past.

**Other Minor Diseases**

**Powdery mildew**

Powdery mildew (*Erysiphe cichoracearum* D.C.), caused by a fungus, has been found on peppermint in some Willamette Valley fields. It has damaged both peppermint and spearmint in central Washington, but as yet has not been serious in Oregon. This disease can be recognized by the gray, powdery fungus growth on the leaves. Heavily infected leaves yellow and soon drop from the plant. Control measures have not been developed for this disease on peppermint.

**Leaf blight**

Leaf blight is caused by a fungus (*Cephalosporium* sp.) that attacks peppermint leaves through openings caused by rust spots, and wounds made by insects or machinery. After entering the leaf, the fungus spreads very rapidly throughout the leaf tissue and may move down the leaf and into the stem. Infection and development of the disease are favored by wet weather and rank growth. Blighted leaves are dark brown or black and soon drop from the plant. Progressive stages of leaf blight are shown in Figure 11. The small, evenly distributed spots on the leaves in Figure 11 are rust spots through which the leaf blight fungus entered.

**Black stem rot**

Black stem rot is caused by an unidentified fungus that attacks peppermint stems during cool, wet weather. Generally the fungus enters the stem through insect- or machinery-caused wounds. As the name suggests, the fungus causes blackened areas of dead tissue on the stems. After stems become girdled, the plant wilts and dies. Black stem rot appears more frequently and is the most damaging in rank, heavy mint. This disease was widespread in the Willamette Valley in 1954 but losses were not serious. Control methods have not been developed.

**FIGURE 11.** Leaf blight. Black, dead areas are caused by fungus entering through rust spots.
PEPPERMINT DISEASE CONTROL PROGRAM FOR OREGON

<table>
<thead>
<tr>
<th>Disease</th>
<th>Control</th>
<th>When applied</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rust</td>
<td>1. Clean plow to turn under all old stubble and plant parts.</td>
<td>Fall or early spring</td>
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<tr>
<td></td>
<td>2. Spray wild and escaped mint with contact weed-killer.</td>
<td>April or May</td>
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<tr>
<td></td>
<td>3. Spray all unplowed or poorly plowed places in field with contact weed-killer.</td>
<td>April or May</td>
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<td></td>
<td>4. Eradicate wild and escaped mint with 2,4-D, or 2,4-D and 2,4,5-T mixture.</td>
<td>July</td>
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<td></td>
<td>5. Dust or spray the crop with Phygon.</td>
<td>Begin about middle of May and continue at 10- to 14-day intervals until 3 or 4 weeks before harvest.</td>
</tr>
<tr>
<td>Verticillium wilt</td>
<td>1. Use only wilt-free planting stock.</td>
<td>At any time</td>
</tr>
<tr>
<td></td>
<td>2. Remove wilt-infected areas from mint production.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Do not use machinery used in wilt-infested fields until thoroughly cleaned.</td>
<td></td>
</tr>
<tr>
<td>Nematodes</td>
<td>Rotate to resistant crop varieties for 3 years.</td>
<td>Every 4 to 6 years</td>
</tr>
<tr>
<td>Root rot</td>
<td>1. Rotate to other crops for 3 years.</td>
<td>Every 4 to 6 years</td>
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<tr>
<td></td>
<td>2. Fall plow, or in flood areas spring plow, as early as practical.</td>
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Peppermint Rust Life Cycle

1. **OCTOBER - DECEMBER**
   Black spore stage on leaves and runners.

2. **JANUARY - MAY**
   Black spores germinate, produce colorless spores on germ tube. These infect young mint shoots (magnified 200 times).

3. **MARCH - JUNE 15**
   Red blisters appear on young shoots.

4. **APRIL - JUNE**
   Red blisters break open releasing thousands of yellow spores.

5. **APRIL - JUNE**
   Yellow spores infect mint leaves and produce brown spores.

6. **JUNE - OCTOBER**
   Brown spore stage repeated many times during summer.