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Biology and Control of the Garden Symphylan



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Biology and Control of the Garden Symphylan

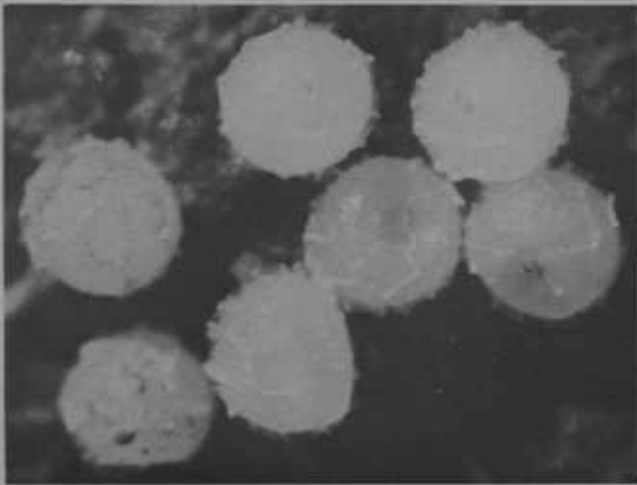
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The garden symphylan (symphylid), *Scutigereella immaculata* (Newport), is a serious agricultural pest in the Willamette Valley in the production of many vegetables, fruits, and several specialty crops. This species also causes extensive damage in home gardens, nurseries, and greenhouses. Symphylans are general feeders which attack germinating seeds, plant root systems, and above ground-plant parts in contact with the soil surface. Surviving plants are stunted and produce poorly in yield and quality. The greatest damage from symphylans occurs in western Oregon, but this pest is becoming increasingly important in other parts of the state.

Description

Symphylans are small, white, soft-bodied, "centipede-like" animals which are not true insects since they possess 12 rather than 3 pairs of legs in the adult stage. Adult symphylans are characterized by 12 pair of legs, 15 body segments, prominent antennae, and paired spinnerets on the posterior of the body. Symphylans reproduce from eggs which are usually deposited in clusters at varying depths in the soil depending on soil structure, temperature, and moisture.



Newly hatched nymphs have six pair of legs, but shortly molt into second instar nymphs possessing seven pair of legs. Molting occurs from time to time, and an additional pair of legs is added with each subsequent molt until the full complement of legs (12 pair) is obtained. Molting continues at intervals during the entire life of

the animal and a single individual has been known to molt as many as 52 times. Members of this group are long-lived and, in the laboratory, reared specimens have survived for more than five years.

Seasonal Life History

Eggs, nymphs, and adults can be found in any month of the year, but the majority of the eggs are found during the early spring and fall months, as shown in Figure 1, page 2. Nymphs and adults become active in the spring and can be found in increasing numbers in the upper six inches of soil during the spring and summer months. They remain in the upper soil until cold, rainy weather or extreme dryness drives them deeper. (See Figure 2, page 2.)

Temperature appears to have an important effect on the distribution and developmental rate of symphylans. In laboratory studies, the average number of days required to complete development from egg to adult decreases as the temperature increases. Total developmental time from egg to adult is 160 days at 50°F, 87 days at 68°F, and 53 days at 77°F.

Laboratory experiments have shown that symphylans have distinct peaks of egg production lasting for about two months, followed by a two- to three-month period when few eggs are deposited. In the laboratory, we can expect about three distinct peaks of egg production during a 12-month period. In the field, however, evidence suggests that there are only two distinct peaks of egg production, one in the spring and another in the fall. In the spring, soil temperature is an important factor stimulating egg production. The spring peak is followed by a three-month period during the summer when few eggs are deposited and a smaller peak of egg production in the fall. Experiments in the field have shown that soil temperatures during the winter months retard egg production and slow the developmental rate of immature stages so that when soil temperature increases in the spring a large number of mature symphylans are present in the population and are stimulated to deposit eggs. Because of the overlapping development of the various stages in the field, the number of generations per year has not been determined. Since it requires about three months to complete development from the egg to adult, there is at least one generation each year and ample time for two complete broods.

Figure 1. Percentage Symphylan Abundance in Soil

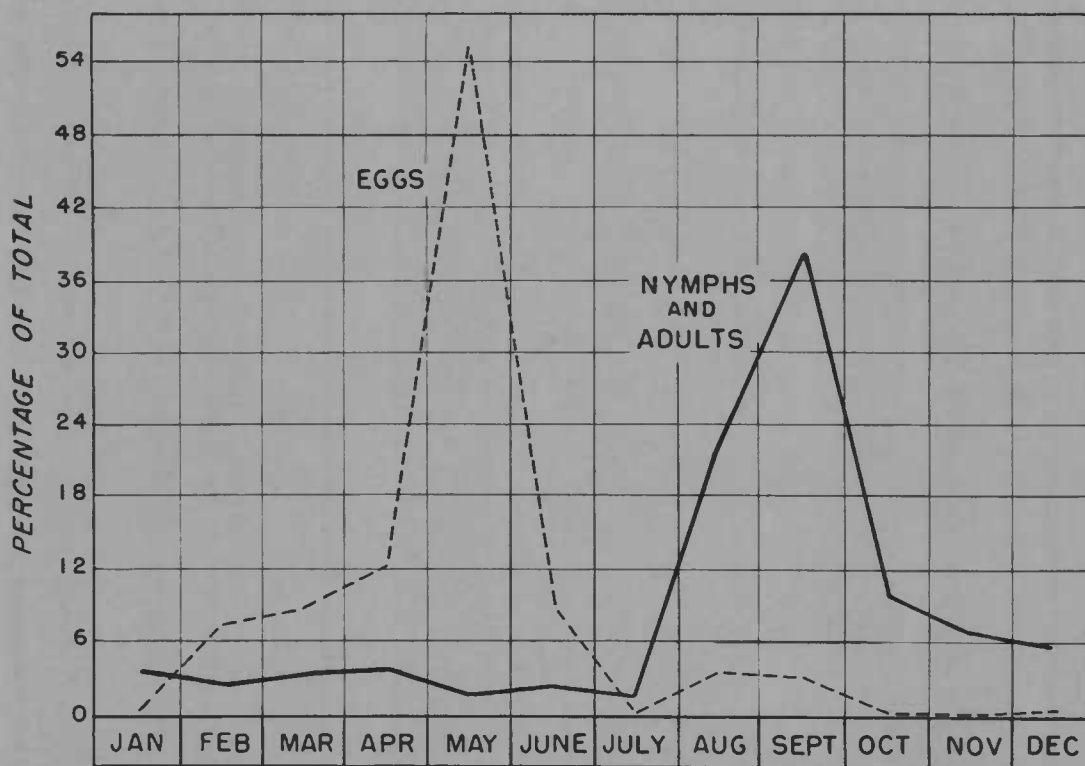
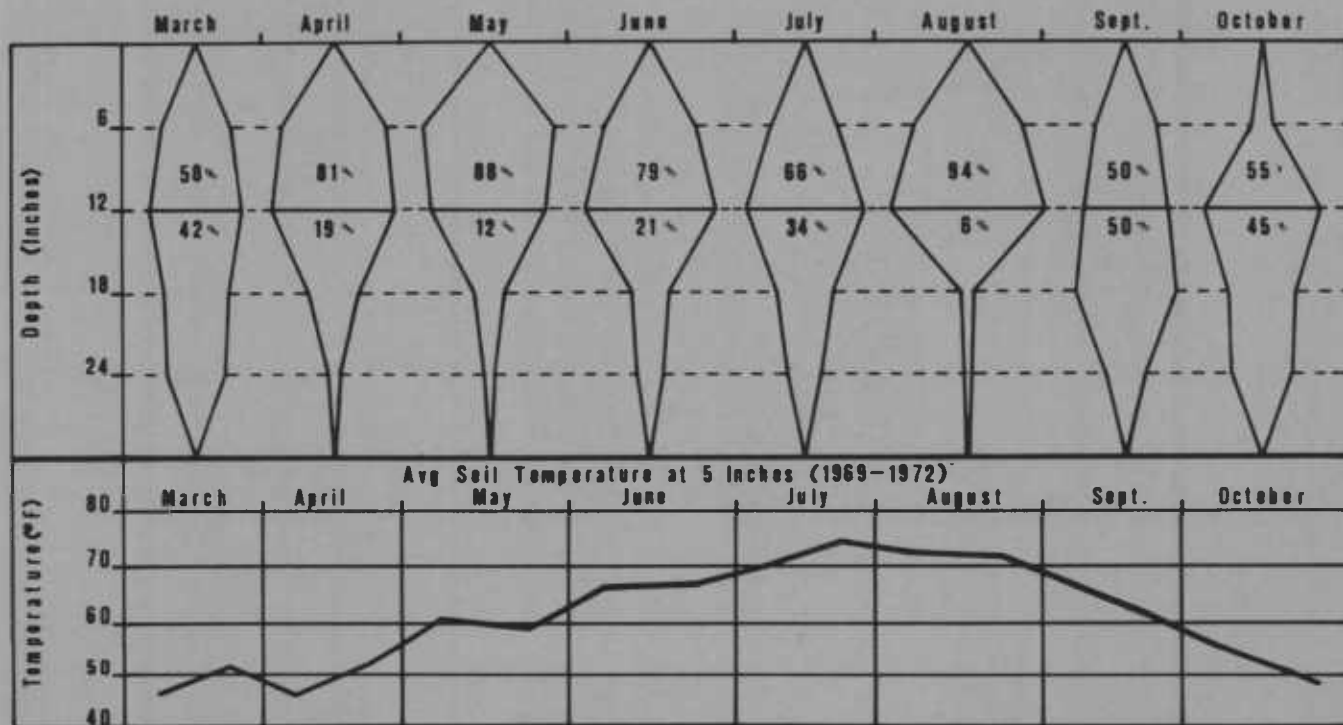


Figure 2. Seasonal Distribution of Symphylans in the Soil
 % Symphylans / Soil Strata



Determining Symphylan Abundance

Symphylans are a potential problem in most Willamette Valley soils. Before planting perennial crops (such as asparagus, mint, hops, strawberries, rhubarb, caneberries, etc.), fields should be surveyed for the presence of symphylans. This may be important even if past history indicates no symphylan problem. Symphylans have been a serious pest the first year after fields have been reclaimed from woodlots or pastures.

Symphylan populations can be determined by counting and averaging the number of symphylans found per sample (ordinary shovelful of soil). A definite problem exists if an average of 10 or more symphylans per shovelful of soil is found after taking 30 or more representative, random samples throughout a field. Symphylans are often found in high numbers in localized or "target areas." If one of these target areas is encountered, particular attention should be given to define the limits of infestation. Frequently in small fields these target areas are scattered and the only safe procedure is to fumigate the entire field. In a large field, only a part of it may be infested and a survey will locate the areas of infestation. These should be "squared off." Squaring off maintains the identity of the infested area and makes chemical control easier.

Conditions favorable to surveys include warm, moist friable soils. In eastern Oregon potato fields, late in the summer after water was removed, symphylans were found to have moved deep into the soil and were found (with difficulty) 12 to 18 inches deep.

Control Methods

No simple, inexpensive, and completely reliable method of controlling symphylans has been developed. Soil fumigation, when properly done, has restored land to full productivity for three or more years. Soil treatments with soil insecticides such as parathion, Dyfonate, and diazinon have retarded symphylans sufficiently to permit satisfactory yields of several vegetable crops. Thorough soil cultivation, such as might be accomplished with rotary type tillers, in market or home gardens can disrupt symphylan activity to a degree that permits satisfactory production of vegetables.

Soil Fumigation

The late H. E. Morrison, of the Oregon State University entomology department, outlined the following recommendations for soil fumigation to control symphylans. His contributions have been invaluable to our understanding of symphylan control by soil fumigation.

1. Planning for Soil Fumigation

It is frequently necessary to plan for soil fumigation months in advance of the actual operation. It is important to determine the extent of the symphylan infestation. In some instances, only parts of a field may require treatment because the center of symphylan infestation (target area) is well-defined by sparse vegeta-

tion and stunted plants. However, symphylans frequently extend a considerable distance beyond these target areas, in spite of the fact that plants appear to have normal vigor. Time spent in locating areas of infestation within the field may enable the grower to make substantial savings in fumigation costs. This would be particularly true if a field survey, as described above, indicated the presence of well-defined target areas of infestation.

2. Soil Preparation

Excessive crop residues in the soil will interfere with mechanical equipment used in soil fumigation. In addition, undecomposed organic matter will absorb or inactivate most fumigants. With the exception of crops with extensive root systems such as alfalfa, mint, and corn, the crop-residue problem can be solved by shredding or beating the cover crop prior to spring plowing. Excessive grain straw can be eliminated by burning and pole bean residue by hauling it from the field. Deep, spring plowing (12 inches or more) should be practiced as early in the spring as possible. This will enable crop residue to decompose by late July or August.

The soil should be in fine tilth with a complete absence of clods to a depth of 10 inches or more. Little can be accomplished by having a well-prepared seed bed (4 to 6 inches deep) which covers a compact plow sole or hard pan condition. (See Figure 3, page 4.)

Recent research and field experiments have pointed to the extreme importance of subsoiling to a depth of at least 20 inches. This should be done every two feet in two directions of the field. Subsoiling should be carried on during July or August when the subsoil is on the dry side. The fact that a field has been subsoiled is no guarantee that the soil has been adequately prepared. Experience has shown that subsoiling in the spring of the year, or early summer, when the subsoil is wet does little to improve soil porosity.

After subsoiling, the field should be thoroughly disced or rotary tilled to achieve a good friable soil condition. This may be difficult to achieve in heavy, clay soils. However, with sufficient care and patience, even the heaviest soils such as Wapato or Cove Clay can be worked into good condition. With conventional machinery, 70 percent of the soil (by weight) to a depth of 15 inches can be made to pass through a half-inch mesh screen. If clods become "sunbaked" during the soil preparation program, they can be softened by one or two inches of water applied by sprinkler irrigation systems. When they become friable, they are easily broken up with conventional tillage equipment.

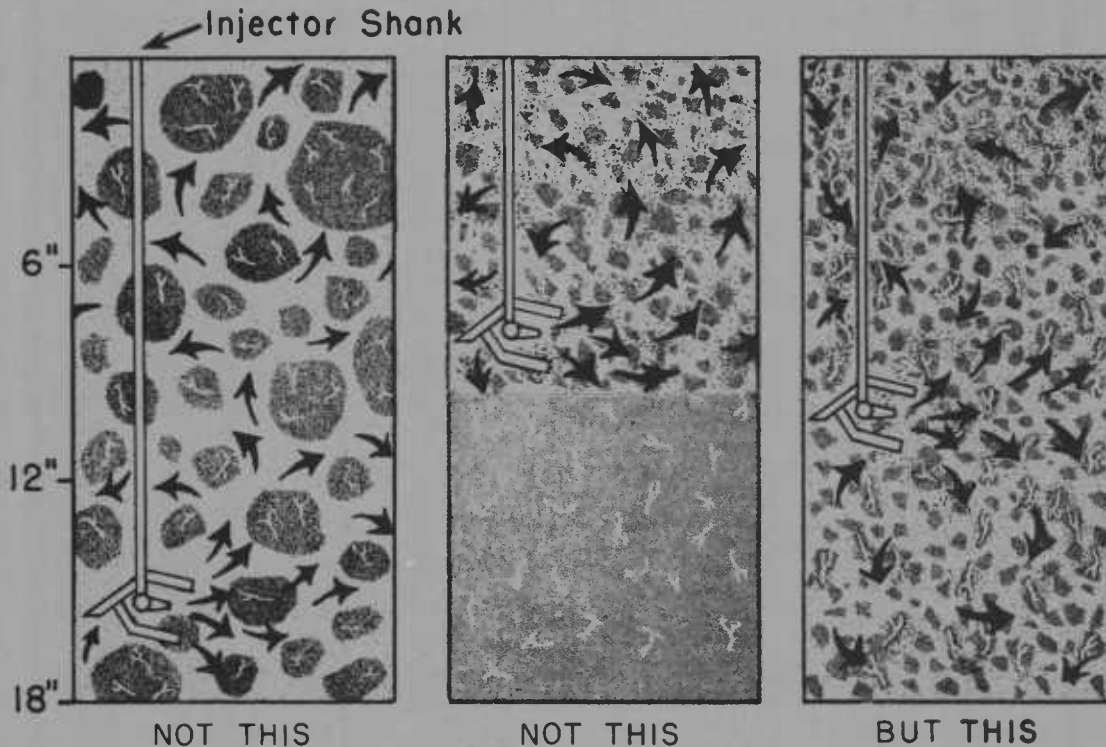
3. Soil Type

Symphylans are common to most mineral soils regardless of their acidity or alkalinity. They have been abundant in soils with pH values ranging from 4.5 to 7.5, but are only occasionally found in peat soils in western Oregon.

Most soil fumigants can be used in mineral soils, but organic soils tend to absorb and inactivate the fumigants,

Figure 3. Soil Profiles

SOIL PROFILES



and they are not generally recommended for use in peat or muck soils.

Symphyllans are sometimes abundant in soils classified as "gravelly phase" types. Unless plastic tarpaulins are used to contain fumigants, it is not likely that successful symphyllan control can be realized in soil with this kind of structure.

4. Timing of Application

Early application of fumigants (May or June) usually results in poor symphyllan control. Best results have been obtained when fumigants have been applied in late July, August, or even September if cold, wet weather does not prevail. Soil temperatures are optimum at this time, and active symphyllan populations are at their highest. (See Figure 2, page 2.)

5. Equipment

If a chisel applicator is used for applying fumigants for symphyllan control, chisel spacings should not exceed 10 to 12 inches (for Vapam, four inches).

When wheel-type tractors are used to pull fumigation equipment through the soil, a firm seed bed is necessary to provide adequate traction. This desired firmness can be obtained by floating or rolling the soil surface.

When fumigating it is important to slightly overlap the fumigated strips. Unless there is a deliberate attempt to overlap it is easy to leave narrow, unfumigated areas. This may result in small infestations of symphyllans

scattered throughout a field. Field margins and corners are frequently inadequately treated unless special attention is given to these areas.

6. Depth of Application

Adoption of the subsoiling practice to break up the plow sole or hard pan condition appears to have eliminated some of the barriers to effective fumigant penetration throughout the soil. If suggestions for soil preparations are followed, little difficulty will be encountered in injecting fumigants to a depth of 12 or more inches.

7. Packing the Soil

In order to prevent fumigants from escaping from the soil too rapidly, the soil should be floated or rolled immediately after fumigants are injected. To accomplish this, the fumigation equipment should not be too far ahead (about one hour) of the sealing operation. After sealing, a light sprinkler irrigation (about $\frac{1}{2}$ inch of water) should be applied, if possible, in order to form a light crust on the soil surface.

8. Planting

Many soil fumigants will kill plants and should not be applied closer than the drip line to established trees, shrubs, or bushes.

The toxicity of fumigants to plants varies according to the dosage, material, crop susceptibility, soil temperature, and so forth. For this reason, no definite rules governing a safe time interval before planting can be

given. Generally a two- to three-week period (one week for each 10 gallons of fumigant used) is sufficient. A thorough discing of the soil before planting will help release any fumigant which may have remained in the soil. In areas subject to flooding, it may be desirable to plant a cover crop two to three days after fumigants have been applied. Rye grass is resistant to the toxic effects of most fumigants, but vetch and other leguminous cover crops should not be planted until the fumigants have left the soil.

The mid-summer application (July-August) of soil fumigants precludes the planting and harvesting of most crops during the same season. However, broccoli, cauliflower, turnips, or rutabagas may in some cases be grown as a fall crop the same year.

9. Symphylan Reinfestation

Symphylan reinfestation of fumigated soil is largely dependent on the initial effectiveness of the treatment and on the proximity of the treated area to infested soil. In small-scale trials (about three plots, each one foot square) both vertical and lateral symphylan reinfestations have been observed within a period of three months.

Infestations of lowlands which are subjected to overflow of flood waters have been observed as emanating from areas where silt and debris have been deposited. In other instances symphylans have apparently been moved from one area to another on planting stock. On occasion, mass migrations of symphylans over the soil surface have been observed.

10. Precautions

Depending on the chemical, soil fumigants may be corrosive, caustic, irritating to the eyes and skin, and toxic if taken internally. To prevent corrosion, all fumigation equipment should be flushed immediately with stove or fuel oil after being used. Adequate precautions concerning the use of fumigants are given on the manufacturers' labels. Special care should be taken not to spill fumigants on shoes or clothing, as these materials may cause severe irritation or blistering. Certain materials such as chlorpicrin (tear gas) or Vapam, when applied under conditions of temperature inversion late in the day, may cause some degree of distress to workers in the field or persons in nearby areas.

11. Role of Pesticide Applicators

Custom applicators equipped for soil fumigation are playing an increasing role in symphylan control. Although adequate soil preparation is critical for the success of the fumigation, most applicators do not undertake this. Soil preparation should be considered an integral part of the treatment and under some circumstances may best be performed by the applicator. This requires a working knowledge of local soil types and management practices.

Soil Fumigant Materials Satisfactory for Symphylan Control

Soil fumigant	Rate per acre	Restrictions and directions*
Vapam	20 gallons or 80 lbs.	Apply in late summer (July, August, or September). Any crop can be grown in Vapam-treated soil. Apply at 4-inch spacings.
D-D mixture Vidden-D	30-40 gallons or 300-400 pounds	Apply in late summer (July, August, or September) to soil to be planted to vegetables, sugar beets, deciduous trees, nut trees, nurseries, turf, field crops, strawberries, vineyards.
Telone	25-30 gallons or 250-300 pounds	Use late summer treatment (July, August, or September) in soil to be planted to annual vegetables, strawberries, and other crops as indicated for D-D mixture.
Vorlex	10-15 gallons or 96-144 pounds	Apply in late summer (July, August, or September). All crops can be planted in Vorlex-treated soil.

* It has been determined that these are non-food uses, therefore, registration may be continued in the absence of finite tolerances.

Soil Insecticides

Dyfonate

Dyfonate is registered for use as a broadcast preplant treatment to control symphylans on several crops including corn (field, sweet, and pop), beans (except limas), cole crops, table beets, sugar beets, potatoes, radishes, strawberries, peppermint, spearmint, and sweet potatoes. A tolerance of 0.1 ppm has been established for residues of Dyfonate on these crops.



Apply Dyfonate at the rate of 20 pounds of the 10 percent granules per acre (2 pounds AI/acre) or spray two quarts of the 4 pound AI/gal-E (2 pounds AI/acre) as a broadcast application prior to the time of planting and incorporate immediately to a depth of 2 to 3 inches by discing.

Dyfonate is also registered for cabbage maggot control on cole crops (2 pounds AI/acre) and for wireworm control in potatoes (4 pounds AI/acre).

Parathion

Parathion is a useful but hazardous material. There is a finite tolerance of 1 ppm for parathion residues on most crops. A maximum dosage of six pounds toxicant per acre as a preplanting soil treatment has been specified, but under Oregon conditions no added benefits have been observed as dosages in excess of five pounds toxicant per acre. *Man and animals should stay out of treated fields for a period of 48 hours following application.*

Although parathion will kill symphylans, its effective life in the soil is short and it will protect crops for only a limited time. In many instances the protective period has been sufficient for plants to establish a good root system and "grow away" from symphylan attack. However, parathion has not always provided the protection needed to prevent severe cullage of root crops. If weather conditions are cold and wet during the spring months, the effectiveness of the parathion treatment is likely to be reduced. Use of parathion for many successive seasons in certain fields has not measurably reduced symphylan populations. Growers who have a serious symphylan problem and choose to use parathion should plan to use it each season for crop protection.

Parathion can be obtained in various formulations. Wettable powders and emulsifiable concentrates are designed for use in spray machinery. Granulated materials and fertilizer mixtures are available for application by fertilizer spreaders. A low percentage (1 to 2 percent) of parathion in the granulated formulation of fertilizer mixture will make it easier to apply evenly over the field.

Any of the parathion formulations can be used for symphylan control. The material should be applied evenly over the soil surface at the recommended rate. Within 30 minutes after application it should be thoroughly mixed into the top four to six inches of soil by means of a disc or rotary tiller.

Since parathion is short-lived in the soil, treated fields should be seeded or planted as soon as possible after the suggested 48 hours safety limitation has elapsed. Seeding or planting when done exclusively by mechanical means may follow immediately after treatment. Poor symphylan control has resulted when planting was delayed two to three weeks after the parathion application.

Diazinon

Diazinon is registered as a preplanting soil treatment for control of symphylans on the following crops: cabbage, carrots, corn, lettuce, peas, pole beans, radishes, red beets, snap beans, tomatoes, and turnips. The registration suggests application of 10 quarts of diazinon AG 500 containing 4 pounds of diazinon per gallon, or 20 pounds of diazinon 50W, or 70 pounds of 14 percent diazinon granules per acre. Immediately after ap-



plication the insecticide should be thoroughly mixed into the top four to eight inches of soil by means of discing or other suitable methods. Under Oregon conditions diazinon has not always adequately protected root crops from symphylan damage.

Precautions

Growers who use parathion or Dyfonate should be aware that these are highly toxic chemicals. Failure to follow precautions may result in serious accidents. Symphylan control involves using parathion at strong concentrations. By comparison, parathion is used at approximately 20 to 40 times the concentration orchardists use. Before using parathion or Dyfonate, carefully read the manufacturer's precautions on the label.

1. Wear protective, waterproof clothing while spraying. Change or launder clothing and bathe daily. Wear rubber gloves at all times when handling these pesticides.
2. Do not eat, smoke, or chew while mixing or applying these pesticides.
3. When using parathion or Dyfonate wear a respirator approved by the United States Department of Agriculture for protection against dusts, mists, and low vapor concentrations of these pesticides. With high exposures use a full-face, canister-type mask. Heed the manufacturer's warnings regarding protective limits of respirators.
4. Never measure or leave mixtures of these insecticides in beverage bottles or in labeled cans or boxes which have formerly contained food products.
5. If concentrate insecticide is spilled on the ground, remove the top layer of soil and bury it deeply. Wash down the contaminated area with lots of water. Follow this with a drench of weak lye solution.
6. Burn or bury empty insecticide bags or other containers. Never re-use them. Paper bags, cardboard boxes, and plastic containers should be burned after

making sure that smoke will not drift over nearby homes, people, livestock, or the person doing the burning. Glass jars should be broken and metal containers crushed or punched with holes for permanent disposal.

7. Keep the pesticide storage shed or room locked.



Symphylans in Perennial Crops

Efforts to control symphylans in established plantings with side dressings or drenches have met with limited success. There has been considerable interest in applying parathion and other materials through sprinkler irrigation systems for symphylan control. The practices of using highly toxic materials, such as parathion or Dyfonate, in this manner introduces a potential hazard to workers engaged in the movement of irrigation pipe.

Another hazard from this practice may result from "drift" onto adjoining pastures, forage crops, and public roadways. Studies have shown that excess residues on food plants may result. Unless so stated on the label, application of materials through sprinkler irrigation systems is neither recommended nor legal.

Symphylans in Home Gardens

Because of many varied kinds of plantings found in home gardens, no general recommendations can be made for symphylan control. *Home gardeners should not use parathion or Dyfonate because of the extreme hazards involved.* Diazinon is registered for use on some but not all vegetables grown in home gardens (see accompanying chart), and could provide sufficient protection for plants to establish a good root system and "grow away" from symphylan attack. The registration suggests application of 10 quarts of diazinon AG 500 containing four pounds of diazinon per gallon, or 20 pounds of diazinon 50W, or 70 pounds of 14 percent diazinon granules per acre. The insecticide should be thoroughly mixed in the top four to eight inches of soil by means of discing or other suitable methods. Treated areas should be seeded or planted as soon as possible after application.

Thorough pulverization of the soil with a rotary tiller immediately before planting will scatter and destroy many symphylans. This practice often makes it possible to grow normal crops in heavily infested soil.

Symphylans in Mint

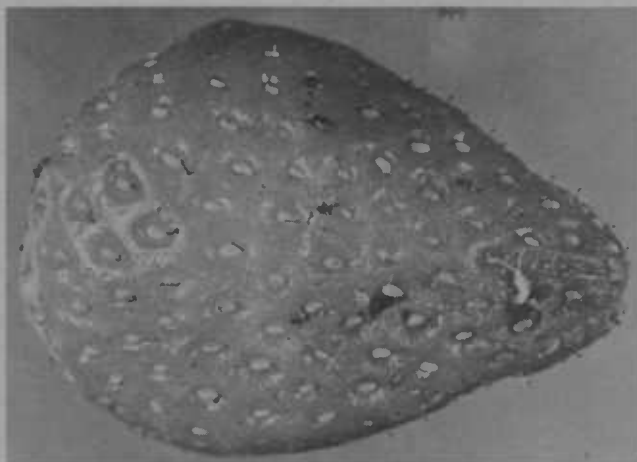
Dyfonate

Dyfonate is registered for control of symphylans in peppermint and spearmint. Apply Dyfonate 10 percent G or 4 EC at the rate of 2 pounds AI/acre broadcast and incorporate to a depth of 2 to 3 inches. Apply either prior to planting or on established mint before spring growth commences. Apply Dyfonate prior to Sinbar and wait at least 14 days between applications of Dyfonate and Sinbar.

Symphylans in Strawberries

Dyfonate

Dyfonate is registered for control of symphylans in strawberries. Apply Dyfonate 10 percent G or 4 EC at the rate of 2 pounds AI/acre as a broadcast treatment and incorporate to a depth of 2 to 3 inches. Apply pre-plant or at transplanting.



Thiodan

In experimental plots dipping plants in a Thiodan solution prior to planting has been effective in reducing symphylan damage. Prepare the dip solution by using two quarts of Thiodan 2 EC (emulsifiable concentrate containing two pounds actual Thiodan per gallon) in 100 gallons of water. Dip the entire plant and plant immediately after draining excess solution. Do not let plant roots dry out before planting. When immersing bundles of plants, make certain any trapped air is forced out to assure thorough wetting of entire plant. Wear rubber gloves during the dipping operation. Ex-

perimental results have shown that protection of young strawberry plants from symphylan injury with the Thiodan dip enables them to become well established and under most conditions will permit plants to develop and produce normal yields during the life of the planting.

Symphylans in Ornamental and Nursery Plantings

A lindane total-soil treatment has been effective for symphylans on non-food crops, when used at the rate of two pounds toxicant per acre (1 ounce toxicant per 1,000 square feet). This dosage approximates four ounces of 25 percent lindane wettable powder, $\frac{1}{2}$ pint of 20 percent lindane emulsion concentrate, or six pounds of 1 percent dust for each 1,000 square feet.

Lindane should be applied evenly on the soil surface and then thoroughly worked into the top six inches. The treatment may also aid in the control of root weevils and white grubs.

Lindane has the undesirable property of imparting objectionable flavors to certain food crops. This property may exist for several years after the materials have been applied. Although this is not considered important in nursery and ornamental plantings, it may become highly important if food plants are used in crop rotations.

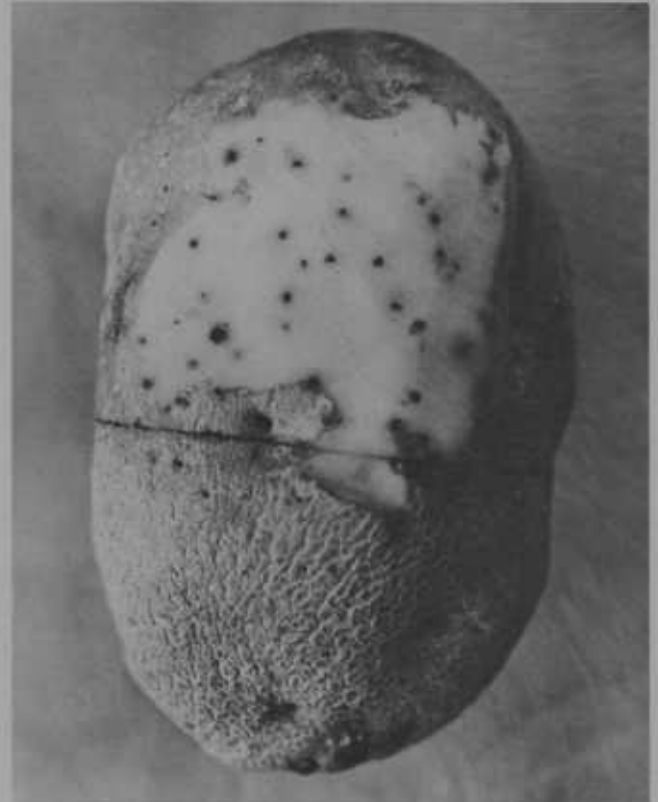
Soil fumigants can be used effectively for symphylan control on land to be used for commercial ornamental and nursery plantings. It may be desirable to use soil fumigants for certain nematodes and thus control two pests with one treatment.

Symphylans in Greenhouses

Under greenhouse conditions, symphylans reverse their seasonal history and become troublesome in late fall

and winter. Damaging symphylan infestations are usually found in ground benches. Parathion, if applied by experienced personnel at the rate of five pounds toxicant per acre (1.8 ounces per 1,000 square feet), is reported to have given good plant protection. Dangers encountered in handling and applying parathion are intensified under greenhouse conditions.

Experience is lacking in the use of soil fumigants in greenhouses. Although symphylans may be satisfactorily controlled by this treatment, escaping fumigants may kill some plants within the greenhouse or even in adjoining ranges.



Registered Insecticides for Symphylan Control

<i>Chemical*</i>	<i>Rate</i>	<i>Crops</i>	<i>Restrictions and directions</i>
Dyfonate 10G or Dyfonate 4 EC	20 lbs./Acre 2 qts./Acre	Corn Beans (except limas) Cole crops Table beets Sugar beets Potatoes Radishes Strawberries Peppermint Spearmint Sweet potatoes	Apply as a broadcast application prior to time of planting and incorporate 2 to 3 inches by discing. <i>On mint, apply Dyfonate prior to Sinbar and wait at least 14 days between applications of Dyfonate and Sinbar.</i> Established mint may be treated prior to spring growth.
Diazinon AG 500 or Diazinon 50 WP or Diazinon 14G	10 qts./Acre 20 lbs./Acre 70 lbs./Acre	Cabbage Carrots Corn Lettuce Peas Pole beans Radishes Red beets Snap beans Tomatoes Turnips	Immediately after application, Diazinon should be mixed thoroughly into the top 4 to 8 inches of soil by discing or other suitable methods. (Under Oregon conditions, Diazinon has not always adequately protected root crops.)
Parathion (several formulations)	5 lbs. active ingredient/acre (1.8 ozs./1,000 sq. ft.)	Most bush and vine fruits, field crops, vegetables and Greenhouses (see container label)	Man and animals should stay out of treated fields for 48 hours. Apply evenly over the soil surface, then immediately thoroughly mix into top 4 to 6 inches of soil by discing or rotary tilling.
Thiodan 2 EC	2 qts./100 gals. water	Strawberries	Dip entire plant and plant immediately after draining excess solution. Do not let plant roots dry out prior to planting. Wear rubber gloves during dipping operation.
Lindane 25 WP or Lindane 20 EC or Lindane 1% dust	4 ozs./1,000 sq. ft. 0.5 pt./1,000 sq. ft. 6 lbs./1,000 sq. ft.	Non-food crops	Apply evenly on soil surface then thoroughly work into top 6 inches. Lindane residues remain in soils for several years and disflavor certain food crops. This may be a factor if food plants are used in crop rotations.

*EC = Emulsifiable Concentrate; WP = Wettable Powder; G = Granules

Home gardeners should not use parathion or Dyfonate because of extreme hazards involved.