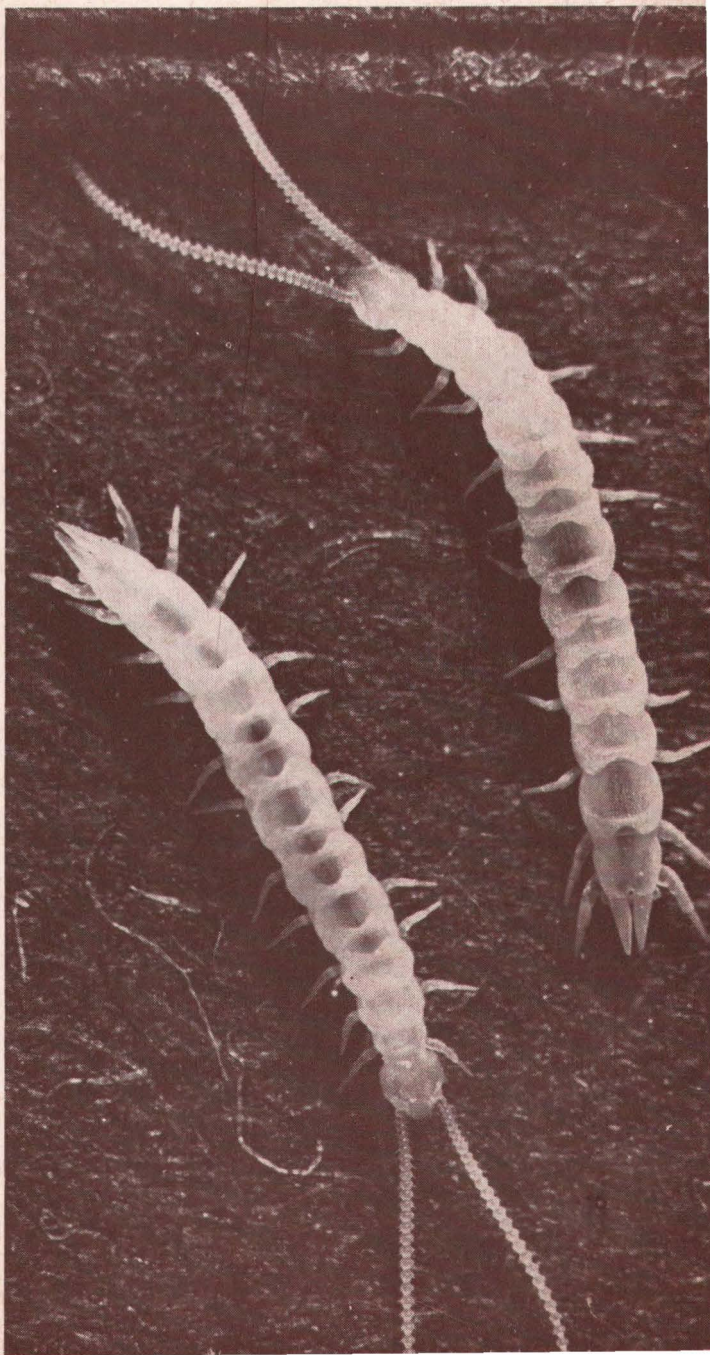


Controlling the Garden Symphylan



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Controlling the Garden Symphylan

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The garden symphylan, commonly referred to as symphyliid, is one of the most damaging pests in Oregon. The greatest damage from symphyllans occurs in western Oregon, but the pest is becoming increasingly important in other parts of the state.

The small, white, centipede-like symphylan feeds on the small roots and other underground portions of plants. Frequently it will enter strawberries when the berries are lying on the ground. Feeding on roots greatly reduces plant vigor and growth or may kill plants. Feeding on beets or potato tubers lowers their market value, and feeding in strawberries results in a contamination problem.

Seasonal history

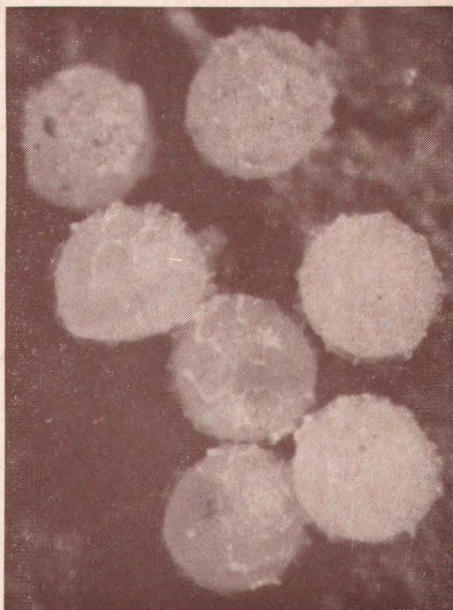
Eggs, nymphs, and adults can be found in any month of the year, but most of the eggs are found during the winter or early spring months. (See the seasonal history chart on page 3.) Nymphs and adults become active in the spring and can be found in increasing numbers in the upper 6 inches of soil during July and August. They remain in the upper soil until cold, rainy weather or extreme dryness drives them deeper.

The life span of a symphylan has not been determined under field conditions. In the laboratory they have lived for over five years and produced eggs periodically during this time.

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 from two to 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.

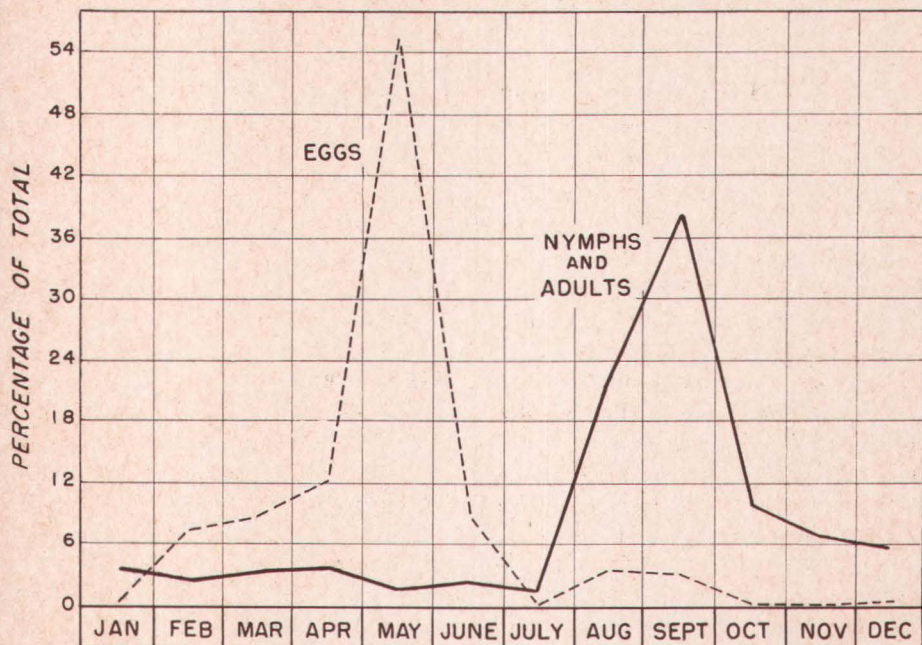
Control methods

No simple, inexpensive, and completely reliable method of controlling symphyllans has been developed. Soil



Symphylan eggs showing characteristic netting on their surfaces.

PERCENTAGE SYMPHYLAN ABUNDANCE IN SOIL



fumigation, when properly done, has restored land to full productivity for three or more years. Soil treatments with parathion or Zinophos have retarded symphylans sufficiently to permit satisfactory yields of such crops as beans or corn. 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.

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 sym-

phylan problem. Symphylans have been a serious pest the first year after fields have been reclaimed from woodlots.

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 the fumigation job 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.

Soil Fumigation

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 vegetation 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.

Soil preparation

Excessive crop residues in the soil will interfere with mechanical equipment used in soil fumigation. In addition, excessive 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 the chart on page 5.)

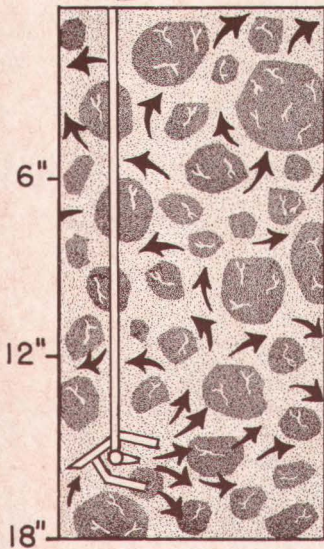
Recent research and field experiments have pointed to the extreme importance of subsoiling to a depth of at least 20 inches. This should be done every two feet in two directions of the field. Subsoiling should be carried on during July or August when the subsoil is on the dry side. The fact that a field has been subsoiled is no guarantee that the soil has been adequately



Two corn plants of the same age. The one on the left with normal root system grew in fumigated soil. The plant on the right grew in heavily symphylan-infested soil.

SOIL PROFILES

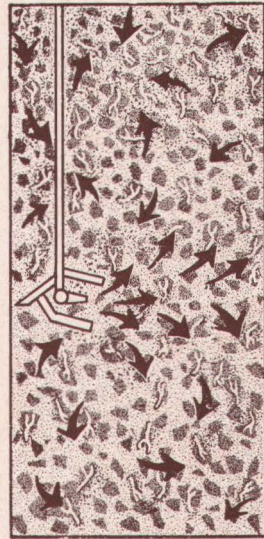
Injector Shank



NOT THIS



NOT THIS



BUT THIS

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. (See the illustration above for good soil fumigation conditions.)

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% 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 1 or 2 inches of water applied by sprinkler irrigation systems.

When they become friable, they are easily broken up with conventional tillage equipment.

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

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

Timing of application

Early application of fumigants (May or June) usually results in poor symphytan 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 symphytan populations are at their highest. (See the seasonal history distribution chart on page 3.)

Equipment

Special equipment is needed to apply soil fumigants. The different types are described in Oregon State University Extension Bulletin 813, *Soil Fumigation Equipment*, by Glen Page, agricultural engineer.

If a chisel applicator is used for applying fumigants for symphytan control, chisel spacings should not exceed 10 to 12 inches (for Vapam, 4 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.

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.

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 equip-

ment 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.

Results of soil fumigant studies

Studies with soil fumigants in large plots ($1\frac{1}{2}$ to 4 acres) in adequately prepared subsoiled soil were started in 1959. The initial symphytan control in all of these plots (14 in number) has been excellent. Symphytans have reinfested only two of these plots four years after fumigation. Some of these plots are still under study, but it is generally indicated that good symphytan control can be anticipated for from three to four years after fumigation.

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. Ryegrass 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.

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 3 plots, each 1 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 has 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.

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.

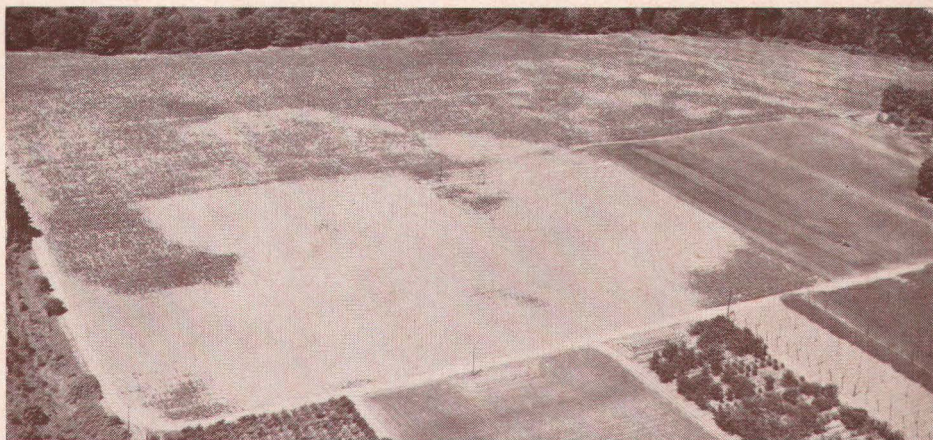
Adequate precautions concerning the use of fumigants are given on the manufacturers' labels. Special care should be taken not to spill fumigants on shoes or clothing, as these materials may cause severe irritation or blistering. Certain materials such as chlorpicrin (tear gas) or Vapam, when applied 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.

MATERIALS

The following fumigants have been found satisfactory for symphylan control:

Soil fumigant	Rate per acre	Tolerance p.p.m.	Restrictions and directions
Vapam	20 gallons <i>or</i> 80 pounds	N.R.*	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	30-40 gallons <i>or</i> 300-400 pounds	N.R.*	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 <i>or</i> 250-300 pounds	N.R.*	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 <i>or</i> 96-144 pounds	N.R.*	Apply in late summer (July, August, or September). All crops can be planted in vorlex-treated soil.

* No residue.



Aerial view of a 42-acre corn field showing almost complete destruction of the corn by symphylans.

Soil Insecticides

Parathion

Parathion, a useful but hazardous material, has been registered for use as a preplanting soil insecticide for all annual crops by the United States Department of Agriculture on a "No Residue" basis. A maximum dosage of 6 pounds toxicant per acre has been specified, but under Oregon conditions no added benefits have been observed at dosages in excess of 5 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 effec-

tiveness 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%) of parathion in the granulated formulation or 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 4 to 6 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 symphytan control has resulted when planting was delayed two to three weeks after the parathion application.

Zinophos

Zinophos (or Cynem 4E) is an organic phosphate insecticide which is as hazardous as parathion to warm-blooded animals. When used as a pre-planting soil treatment, Zinophos has been effective for symphytan control at dosages of 2 to 5 pounds toxicant per acre (2 to 5 quarts of the emulsifiable concentrate). It is longer lasting than parathion in the soil and has measurably reduced symphytan numbers.

However, after the experimental use of Zinophos in heavily infested areas

for three successive seasons, symphytans have not been eliminated. Growers who have a serious symphytan problem, and choose to use Zinophos, may find it necessary to apply it each season for satisfactory crop protection.

Zinophos is now registered on a "No Residue" basis by the United States Department of Agriculture for use where broccoli, Brussels sprouts, cabbage, cauliflower, mint, snap beans, and corn are to be grown.

Zinophos can be used for symphytan control as either a broadcast or band treatment immediately before planting. If a broadcast application is used, mix 2 pounds (2 quarts) of Zinophos in 30 or more gallons of water and spray evenly on one acre of soil. Immediately after application, mix the Zinophos into the soil to a depth of 4 to 6 inches by discing or rotary tillage. This should be accomplished the same day that application is made to prevent excessive loss through volatilization.

Depending on width of row spacings, from 50 to 60% savings in ma-



Symphytans reduced the growth of the cabbage plants shown above. Because they can move deep in the soil, symphytans are difficult to control.

terial costs can be realized by treating 18-inch bands and planting crops in the center of the treated bands. To do this, equip the sprayer with a weed nozzle (8003E) mounted 10 inches above the soil surface. Calibrate the sprayer to deliver $8\frac{1}{4}$ pints of water per 1,000 lineal feet (1,500 square feet). Mix Zinophos 4E at the rate of one pint for each $7\frac{1}{2}$ gallons of water and apply over the center of the row. Thoroughly mix the treated soil to a depth of 4 to 6 inches with a disc or rotary tiller, in the same direction as the treated band.

For symphytan control in mint, the recommended rate of Zinophos is 5 pounds (5 quarts) per acre sprayed on the soil surface and immediately worked into the soil during the fall plowing operation. As a spring treatment (April), use 2 pounds (2 quarts) during spring plowing or cultivation.

For symphytan control on strawberries, Zinophos may be used as a pre-planting soil treatment at the rate of 2 pounds (2 quarts) per acre. Zinophos may also be used as a post-harvest treatment by spraying $1\frac{1}{2}$ pounds ($1\frac{1}{2}$ quarts) directly over the rows and immediately following the treatment with an irrigation. The post-harvest treatment should not be made later than

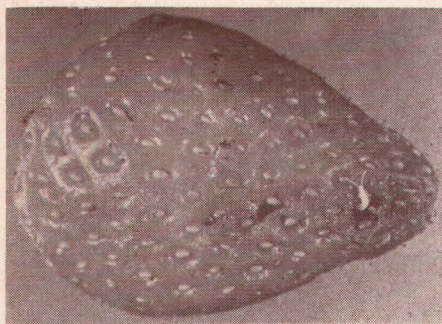
August 15. Zinophos may be used as a post-harvest drench. Dilute 4 ounces of Zinophos (4 pounds per gallon E.C.) in 100 gallons of water. Apply 8 ounces of the dilute solution per plant, but do not apply within 90 days of harvest.

Zinophos is registered for use on other crops not included in this publication. These uses are described on the labels. Any departure from the directions may lead to chemical-residue problems. Zinophos should not be applied with aqua ammonia fertilizer. The basic nature of aqua ammonia will inactivate Zinophos rapidly. This reaction takes place in the injection equipment. It does not occur in the soil, and no unfavorable reaction results if aqua ammonia and Zinophos are applied separately. Parathion and other organophosphorus pesticides probably would also be reduced in effectiveness if used in combination with aqua ammonia fertilizers.

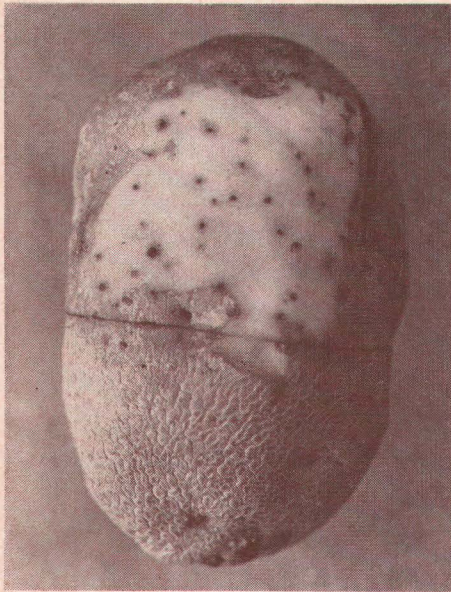
Precautions

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

- Wear protective, waterproof clothing while spraying. Change or launder clothing and bathe daily. Wear rubber gloves at all times when handling parathion or Zinophos.
- Do not eat, smoke, or chew while mixing or applying these pesticides.



Symphytan feeding in a ripe strawberry, resulting in food contamination.



Symphylan-damaged potato tuber. This injury closely resembles that caused by the tuber flea beetle.

- When using parathion or Zinophos, 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.

- Never measure or leave mixtures of these insecticides in beverage bottles or in labeled cans or boxes which have formerly contained food products.

- 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.

- Burn or bury empty insecticide bags or other containers. Never reuse them. Paper bags, cardboard boxes, and plastic containers should be burned after making sure that smoke will not drift over nearby homes, people, livestock, and the person doing the burning. Glass jars should be broken and metal containers crushed or punched with holes for permanent disposal.

- 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 practice of using highly toxic materials, such as parathion or Zinophos, 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, or 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 not advisable.

Zinophos is now registered for use on strawberries when applied as a drench (sprayed over the row) and watered in. This particular treatment should not be used until after harvest and not later than August 15.

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 2 pounds toxicant per acre (1 ounce toxicant per 1,000 square feet). This dosage approximates 4 ounces of 25% lindane wettable powder, $\frac{1}{2}$ pint of 20% lindane emulsion concentrate, or 6 pounds of 1% dust for each 1,000 square feet.

Lindane should be applied evenly on the soil surface and then thoroughly worked into the top 6 inches. The treatment may also aid in the control of root weevils and white grubs.

Lindane has the undesirable prop-

erty of imparting objectionable flavors to certain food crops. This property may exist for several years after the material has 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 5 pounds toxicant per acre (1.8 ounces per 1,000 square feet), is reported to have given good plant protection. Dan-

gers 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.

Symphylans in Home Gardens

Because of the many and varied kinds of plantings found in home gardens, no general recommendations can be made for symphylan control. *Home gardeners should not use parathion or Zinophos because of the extreme hazards involved.*

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.

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