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Symphylans IPM

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December 2023

(UC IPM)

Background Info

- Description:
  - Aka garden centipede, *Scutigerella immaculata*.
  - Elongate, white "centipede-like" arthropods (myriapods) with long antennae.
  - When full grown, they are approximately ½ inch long or less with 11-12 pairs of legs.
- Damage:
  - They feed on living roots, sprouting seeds, and fungal hyphae.
  - Feeding damage causes root death, gnarled appearance, corky tissues in older roots, stunting, increased susceptibility to soil-borne pathogens.
  - They cause patchy distribution of symptoms in the field and often occur in hotspots which can be several square feet to several acres in size.
  - They create a dramatic distinctive circular pattern of crop stunting in a field.
- Hosts: include brassicas, solanaceous crops, root crops, cucurbits, some leafy greens such as spinach and mustards. They especially love carrots, beets, other root crops.
- Timing: often high numbers are observed in April/May especially during rainy springs.
- Soil moisture: symphylans tend to occur in heavier soils with high irrigation. Symphylans may be spread by flooding and are common in alluvial soils in California. Symphylans tend to congregate in the upper soil layer when conditions are warm and moist.
- Soil organic matter and soil structure: they cause problems in organic systems with high SOM, plant residue incorporations, and non-decomposed organic matter.
- Soil structure: symphylans are more often associated with good soil structure compared to soils that are compacted or sandy.
- Mobility:
  - They rely on soil pore spaces made by roots and other organisms to move.
  - They are very vertically mobile in soil profile thru soil pores, cracks, and channels.
  - They need well aggregated soil for movement, so sandy soils are less hospitable.
  - They can be found more than 3 ft below the soil surface.
  - All life stages occur in the soil--they molt in the deeper soil layers and migrate up to the root zone to feed.
- Ironically, they could be considered the single pest that is an indicator of good soil management where soil aggregation and soil organic matter are high.

Integrated Pest Management Options

IPM provides a toolbox approach to pest management: choose a combination of management options that makes sense for your context.

Damage Prevention

- In problem areas, plant tolerant crops such as beans, small grains, spring oat cover crops.
- If symphylans are known to be an issue in the area, moderate organic matter inputs especially of fresh plant residues.

Monitoring

- Record keeping: keep track of which fields have symphylans issues. Consider making a map of symphylans hotspots based on bait trapping results.
- If you can see them in the soil before planting, it means symphylans are numerous enough to cause economic damage.
- Bait trapping (aka the potato test): just before planting in the spring, use bait trapping to monitor garden symphylans and determine population levels present.
    1. Install potato slices in soil. Cut raw potatoes, beets, or carrots in thick slices. Carefully rake away the upper drier soil layer until moist soil is exposed. Scratch the cut surface of the potato immediately before placing it on the moist soil surface. Be careful when removing dry soil from the surface not to disturb the soil pores which could prevent symphylans from reaching the bait. This can be done by raking the surface soil away with a lettuce knife. Use at least 1 bait trap per acre, ideally more for small-scale farms. It can be helpful to compare symptomatic areas with nearby high performing areas.


    2. Cover the bait and wait. Cover potato slices with a cup to protect them from drying out. Make sure the cup is large enough to prevent excessive heating of the area or to accumulate a lot of condensation. A cup or white plastic pot (with no drainage holes) about 6 inches x 6 inches is adequate. Cover with a stone or some soil to prevent the wind from removing it. Leave the bait in place for 24 to 36 hours.

    3. Count symphylans present. Remove the cover to count the symphylans on the potato slice and on the soil surface underneath. Count the soil surface first as the symphylans there will quickly run away and hide (they move quickly). If any symphylans are present on the bait, significant stand loss can occur and taking action would be justified (see management options below).

Symphylans on potato slices and soil.

Biological Control

- Promote predatory organisms such as predatory mites, ground beetles, true centipedes, fungi. Consider installing and maintaining insectary plants to attract natural enemies of symphylans, but bear in mind biocontrol alone will likely not be enough to control symphylans.

Mechanical Methods

- Tillage: an effective traditional control tactic for reducing symphylans populations.
    - Tillage directly kills symphylans and destroys the pore spaces and channels symphylans use to move thru the soil.
    - However, it decreases populations of key predators of symphylans as well (such as centipedes and predaceous mites), and over time reduces soil organic matter content and soil structure.
    - Tillage when symphylans are near the soil surface can provide several weeks of control, however it does not control symphylans at lower soil depths. Consider benefits and tradeoffs of tillage.
- Potato rotations: decrease symphylans populations and in some cases can allow other more susceptible crops to be planted after potatoes.
- Limit organic matter inputs: reduce input of undecomposed organic matter.
- Mild/moderate compaction: packing down the soil surface after planting compresses pore spaces that symphylans use to travel and can help reduce symphylans movement through the soil.

Cultural Methods

- Limit organic matter remaining in the field: remove crop residues, do not till in crop residues where symphylans are present, and do not leave any unharvested root crops in the field.
- Sanitation: clean farm equipment between going from field to field and to new farms to minimize the risk of spreading symphylans to new areas.

- Wait to seed/transplant until any organic materials have visibly broken down.
- Overplanting: plant a higher number of seeds/transplants in problem areas to help compensate for anticipated damage.
- Using transplants rather than seeds can help give crops more of a head start.
- Soil amendments vary greatly in their effects and reports are often contradictory.

Organic Insecticides and Oil-based Products

- There are many options. Mention of pesticide products do not constitute endorsements, merely examples of registered products that can be used for this specific pest.
- The crop system where you intend to use a pesticide product must be listed on the label. Always follow the pesticide label carefully and consult ipm.ucanr.edu for further resources.
- Organic insecticides are likely most effective if applied before planting.
- Azadirachtin based insecticides: an active ingredient extracted from the neem tree
- Pyrethrin based insecticides: an active ingredient found naturally occurring in Chrysanthemum flowers, provides some low level of control
- Oil based products: can provide a moderate level of control, ingredients examples include clove oil, cinnamon oil, thyme oil, rosemary oil
- Notes: insecticides will kill symphylans near the surface and allow better root establishment. Spot treatments with insecticide may be adequate. However, symphylans deeper in soil may eventually reinfest the root zone. Using a combination of IPM strategies will provide the highest level of pest control, rather than relying on one strategy alone.

Grower Perspectives and Anecdotes

- Growers with experience managing symphylans have kindly provided their input about IPM and key questions that need more research.
- Good record keeping
    - Some growers use notes, drone imaging, maps of potato bait test results, etc.
- Recognizing symptoms
    - Growers report that they look for distinctive circular pattern of damage, aka “circle of death” (Emma Torbert at the UC Davis Student Farm, Heidi Hermann at Strong Arm Farm).
    - “I have also used beets for the potato test and it’s kind of cool because the symphylans are easy to see with their pink/red insides.” (Tessa Henry, Clif Family Farm).
- Crop susceptibility anecdotes
    - Most susceptible crops tend to be: root crops, eggplant, sweet potato, brassicas, cucurbits, solanaceous crops.
    - Less susceptible crops include: beans, lettuce, alliums, cover crops, certain grains.
- Potato rotation and interplanting
    - Timing may make a difference: at a site with symphylans history, potato rotation showed effectiveness when planting a vegetable crop immediately after harvesting potatoes in the fall (Scott Chang-Fleeman at Shao Shan Farm).

    - Interplanting potatoes with crops can provide some level of control for nearby susceptible crops (Jacob Tracy at CIA Copia).
    - "Planting potatoes before brassicas has been key for me." (Tessa Henry, Clif Family Farm)
- Biocontrol and natural predators
    - "When I worked at the Standford U farm we had symphylans and a few free range chickens. I noticed the chickens really loved hanging out in the beds that we abandoned from symphylans and then the next year the symphylans were not a problem in that area. So anecdotal, but it really makes a lot of sense to me and it is a good natural pest control option! Obviously the downside is the fallow time for the chicken manure to break down and the challenges there but I think it could be managed." (Rose Madden at Pink Barn Farms)
    - Fully decomposed compost might lead to less symphylans issues than non-decomposed plant residues (Elizabeth Kaiser at Singing Frogs Farm, Rex Dufour at ATTRA).
- Weeds as hosts
    - "Just anecdotally: One year we were super on top of the weeds in the symphylans hot spot zones and they absolutely annihilated the crops. When we let the weeds go crazy the crops looked better (it seemed like they were spreading out their damage to the weeds)" (David Plescia at West County Community Farm).
- Climate and rainfall
    - No reductions in symphylans populations were observed following the wet winter 2022-2023 and cool spring—it seems this weather may have encouraged symphylans. We need more information about how temperature and rainfall might affect symphylans (Jim Leap).
- Chitin-containing amendments
    - Some growers report trying out crab meal amendments, but there is little consensus about efficacy. Some growers till in the crab meal and are unsure whether any level of control can be attributed to the physical disturbance of tillage vs. the crab meal.
    - There has been some limited research on chitin-containing shrimp or crab shell applications for symphylans control but no significant effects have yet been found (WSARE Farmer/Rancher Project link).
- Organic insecticides and oil based products
    - The products most used by growers include neem oil and essential oil-based products.
    - The main barriers preventing growers from using organic oils and organic insecticide products include: expense, lack of time, lack of confidence in application procedure, lack of certification (Operator ID number), unclear label directions regarding environmentally safe application practices, concerns about off-target risks, runoff and water quality.

Remaining Questions and Areas for Future Research

- Symphylans biology and behavior
    - Can you import symphylans to your site through compost, or do they grow "in place" as soil health improves over time? It seems likely they could be imported in compost and survive on the edges of compost piles where temperatures are less extreme (Jim Leap).
    - Is fully decomposed compost less likely to encourage symphylans population grow compared to use than non-decomposed residues?
    - Why do symphylans start in a hotspot? How does this start? How can we better understand their growth pattern? (Jim Leap)
- What is the mechanism behind the reduction of symphylans populations after a potato rotation?
    - The physical soil disruption involved with harvesting them? (idea from Johnny Campbell at Santa Rosa Jr. College Shone Farm)
    - A biochemical effect from the potatoes? (idea from Rex Dufour at ATTRA, Jen Lang at 7 Roots Ranch)
    - A long-term bait effect? Since there are usually a small number of potatoes left in the field after harvesting them, maybe those leftover ones act as baits and distract the symphylans away from any new transplants? (idea from Emma Torbert at UC Davis Student Farm)
    - Removal through harvested potatoes? Maybe they are in the potatoes and you're moving them out of the field at harvest? (idea from Scott Chang-Fleeman at Shao Shan Farm)
    - This could be a great research question for an entomology graduate student.
    - Exactly how long do the benefits of the potato rotation last in the field?
- Biocontrol and natural predators
    - Are there any biocontrol options / beneficial predators that could help control symphylans? (many growers asked this question—more interest in this question than organic insecticides)
    - Three growers mentioned observing high levels of predatory centipedes in beds with high symphylans levels (Katie Davis at Silver Oak, Jess Arnsteen at Long Meadow Ranch, Elizabeth Kaiser at Singing Frogs Farm). Centipedes and ground beetle larvae are predators known to attack symphylans.
    - How can we best promote predatory organisms?
    - What are other soil-ecology oriented approaches to symphylans IPM and practical tests and tools growers can use?
    - In one no-till system with frequent high compost inputs, growers have had relatively infrequent symphylans issues. Symphylans have come up about 5 times in the past. Their quick response is to get rid of the crop that has symphylans, put in compost, and replace with a new crop. That worked most of the time except for quicker crops that were in raised beds. At one point, there were three successions that all suffered in raised beds (lettuce, mustard, another green). Growers replaced ⅓ of the raised bed soil with field soil and the symphylans issue went away. (Elizabeth Kaiser at Singing Frogs Farm). Maybe it could be because of beneficial

biology in the field soil? Maybe also the initial physical disturbance of replacing bed soil helped reduce symphylans? And biota in field soil helped maintain no symphylans over long run like predatory centipedes?

- Could solarization and tarping help? Emma Torbert (UC Davis Student Farm) has noticed lower symphylans damage after soil solarization. Another grower, Tessa Henry (Clif Family Farm), found that resting and summer tarping one block with high symphylans populations might have helped reduce their levels before the next crop.
- Need more research-based information to help guide IPM best practices
    - Need more research on organic essential oil products and organic insecticides.
    - Need practical and affordable management solutions.
    - Need more science-based research results from randomized and sufficiently replicated field trials that are centered around grower-driven research questions.
- As more and more growers adopt healthy soil practices, we will probably continue to see symphylans pressures increase (Rex Dufour at ATTRA).

See this ATTRA article for more information and helpful photos:
https://attra.ncat.org/publication/symphylans/

References

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https://extension.usu.edu/pests/ipm/notes_ag/veg-garden-symphylans
https://pnwhandbooks.org/insect/ipm/garden-symphylan
https://projects.sare.org/project-reports/sw03-033/
Communications with Jim Leap, retired UCSC Farm Manager
Communications with Rex Dufour, ATTRA NCAT
Communications with Emma Torbert, UC Davis Farm Manager
Communications with many growers who have experience managing symphylans via focus groups, farm visits, emails, and phone calls