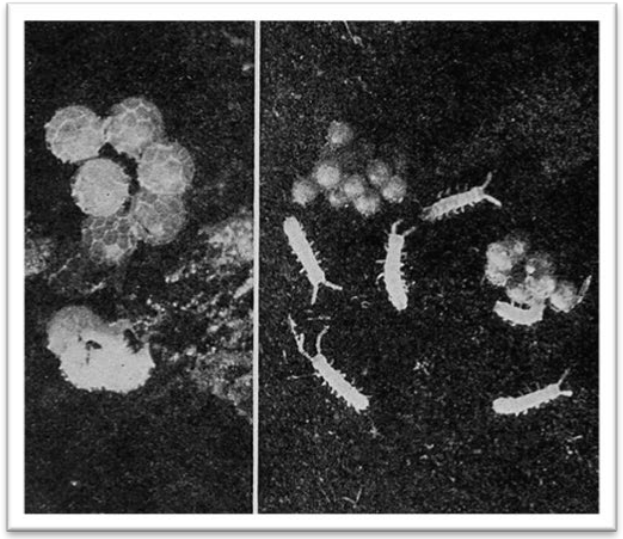
Symphylan Project Research Findings

Symphylans/Symphylids/ Garden Symphylans

- Soil-dwelling arthropods (not insects)

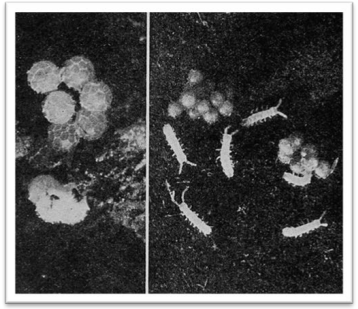
Subphylum Myriapoda, Class: Symphyla

- Small, white to translucent < 1/8–1/4 inch long
- Fast-moving
- 12 pairs of legs (adults)



Symphylans/Symphylids/ Garden Symphylans

- Live in the upper soil profile (typically top 12 inches), but can recede upto 3 feet
- Feed on plant roots and seedlings, feed on Organic matter or fungi in fallow fields
- Cause stand loss stunting, and uneven growth
- Chronic, difficult-to-manage pest in the Willamette Valley



Symphylan Distribution in the West

- Garden symphylans are globally distributed, **but the Pacific Northwest especially western Oregon** has experienced the most persistent and economically damaging infestations

JOURNAL ARTICLE

The Garden Centipede, *Scutigerella Immaculata* (Newport), a Pest of Economic Importance in the West

F. H. Wymore

Journal of Economic Entomology, Volume 17, Issue 5, 1 October 1924, Pages 520–526,
https://doi.org/10.1093/jee/17.5.520
Published: 01 October 1924

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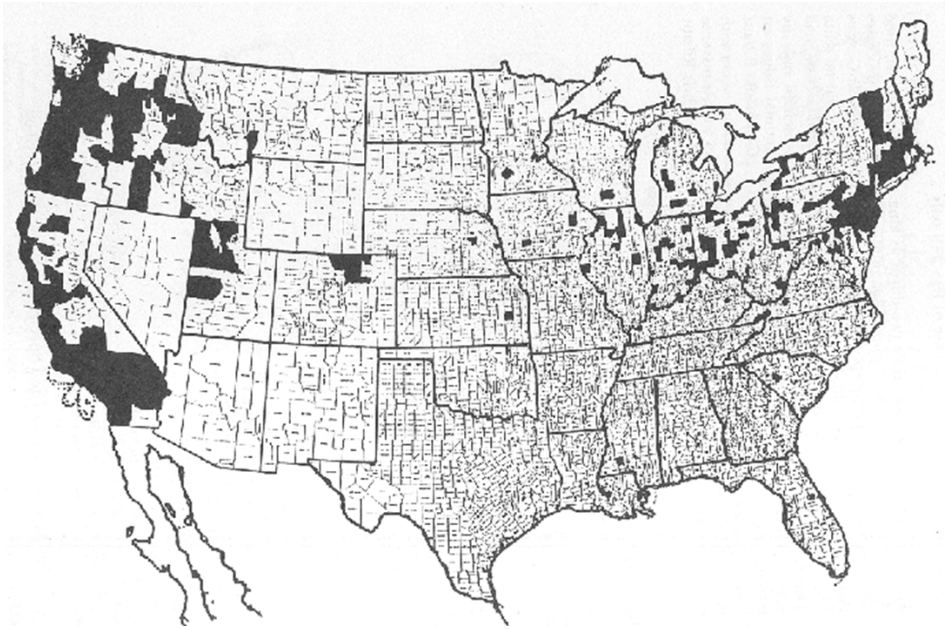
Abstract

The garden centipede, *Scutigerella immaculate* (Newport), is found widely distributed throughout the world and has been studied by zoologists for many years in relation to the supposedly ancestral characters of insects, chilopods and diplopods. In recent years it has been considered by economic entomologists of California, Oregon and Utah as among the most important and destructive pests in many truck crop sections of these States. In California it is



Garden Symphylan Research

- Most garden symphylan research activity has been centered in Oregon/PNW since the mid-20th century
- Early work in California and Europe (1905–1955)
- Shift to Oregon beginning in the 1930s
- Applied & Extension focus from the 1990s onward

Research 2022- present

Chemical Control Research – OSU

- Evaluate chemical and reduced-risk tools (Group 3 A, 21, 28, and 30) for managing garden symphylans in Oregon cropping systems
- Highly variable efficacy across products and sites
- Bifenthrin-based products, either liquid fertilizer ready or other formulations provided suppression in grass seed trials

Results- Spring 2022, Efficacy Trial in Radish

Treatment	Symphylan Counts per Plot				
	10 DAT	14DAT	25 DAT	32DAT	39DAT
Torac/Tolfenpyrad	1.25	0.5	1.25	0	0
Verimark	1.5	0.5	3.75	1.5	0
Capture	1.25	0	0.25	0	0
Broflanilide	2	0	10	3.25	0
Isocycloseram	2	0	3.5	0.25	4
Control	5.25	0.25	4.25	3	0.5
P value	0.0691	0.493	0.3722	0.1266	0.4729

- **Capture and other insecticide treatments started out strong but significant reductions were not observed**

Insecticide Performance

- Bifenthrin provided, at best, short-term suppression and is not a reliable stand-alone solution for symphylan management in Oregon

- Reductions in symphylan counts were temporary, most often observed only within 10–14 days after treatment

- Population rebound was common at later sampling dates

- Activity is primarily contact-based, limiting exposure in soil systems, which is why chemical management is tricky

Beyond Conventional Insecticides

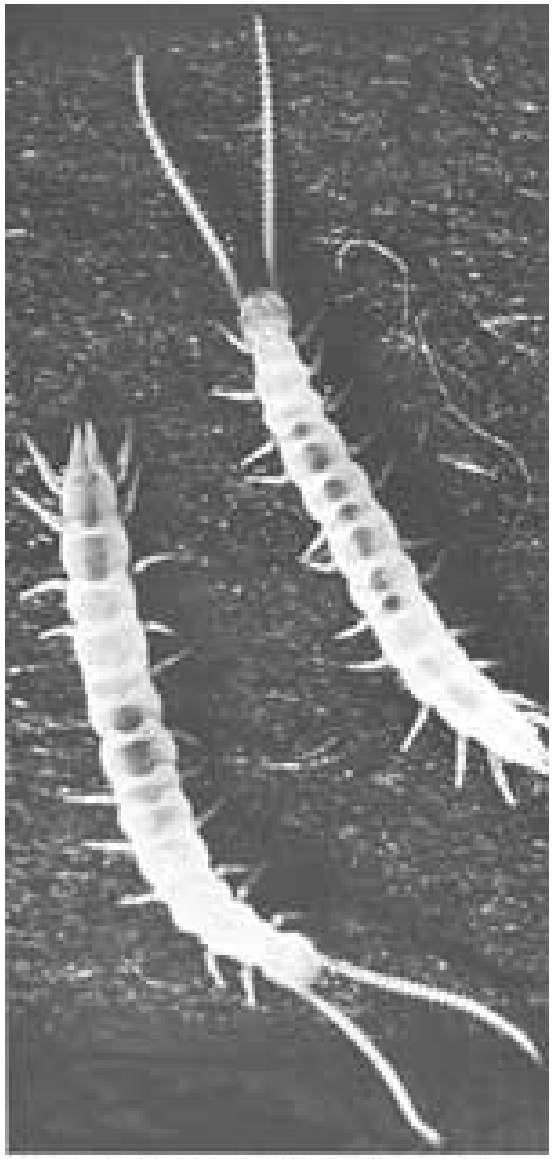
- Symphylans are soil-dwelling, root-feeding pests, making contact insecticides difficult to deliver effectively

- Microbial-based insecticides may persist and propagate in soil, offering potential for longer-term activity

- Generally lower risk to beneficial organisms, soil health, and applicators

- Provide alternative modes of action, supporting insecticide resistance management

- Better alignment with integrated pest management (IPM) strategies



The Garden Symph. OSU Photo

Spinosad Bait Formulations

Seduce® Insect Bait – Spinosad (spinosyn A & D) (IRAC Group 5)

- Actively attracts soil-dwelling pests, rather than relying on random contact
- Delivers the active ingredient directly to the root zone, where symphylans feed
- Can provide more consistent performance than contact insecticides in soil
- Often lower risk to beneficial soil organisms and compatible with IPM

On Farm Trial 2024- Commercial Sugar Beet Seed Production in Lane Co.

Performance of Seduce® Insect Bait in Symphylan Trials

2024 Sugar Beet Seed Trials

- Seduce significantly reduced symphylan densities compared with the untreated control
- Performance was comparable to the experimental product A21377X

Treatment	lb ai/A	IRAC Group	Site 1		Site 2	
			----------LS means*----------			
Control			24.10	a[a]	19.7	a
No-fly (Isaria fumosoroseus strain FE 9901)	0.36	UN	21.60	a	15.7	a
AzaGuard (azadirachtin) (OMRI listed)	0.033	Botanical	19.25	ab	10.9	a
Seduce Insect Bait (spinosad)	0.031	Group5	13.40	bc	16.1	a
A21377X (isocycloseram)	0.1	Group 30	13.00	bc	22.6	a
Capture LFR (bifenthrin)	1.765	Group 3	8.50	c	9.75	a
P-value			0.0001		0.3944	

2024 Trial in Vegetable Seed Field in Lane Co.

Performance of Seduce® Insect Bait in Symphylan Trials

Early suppression during crop establishment

- At 9 DAT, Seduce significantly reduced symphylan abundance compared with the untreated control
- Seduce plots had numerically higher biomass than the control and AzaGuard-treated plots

2024 Trial in Vegetable Seed Field in Lane Co.

Treatment	9 DAT	16 DAT	22 DAT	% Biomass
Control	19.8a	20.5a	23.3a	12.9a
AzaGuard	16.0a	16.5a	11.3a	17.7a
Seduce Insect Baits	5.0b	5.5a	13.5a	26.8a
P-value	0.0202	0.2064	0.2119	0.1269

2025 Research Directions

Goal:

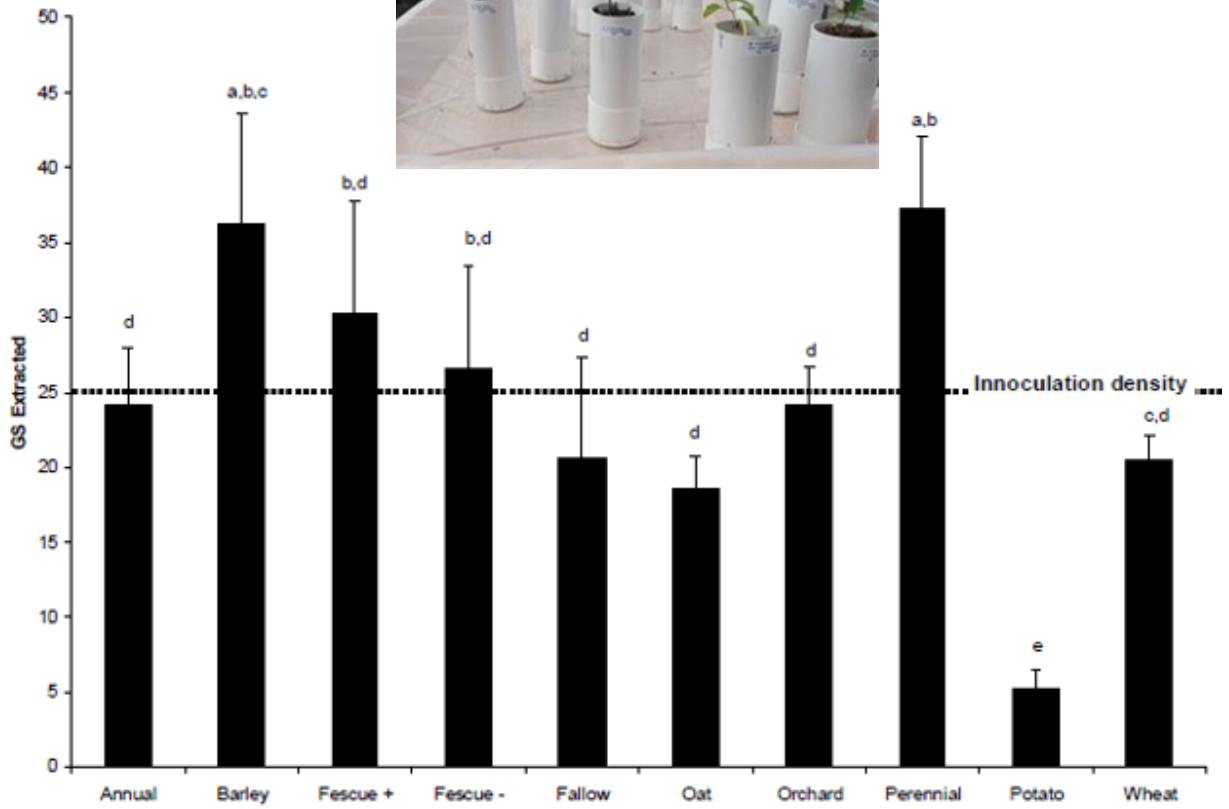
- Explore the **potential of glycoalkaloid-rich crops as cover crops or rotation options** for managing symphylan populations

Objectives

1. Determine the direct effects of glycoalkaloids on symphylans
2. Determine the suitability of solanaceous crops with high glycoalkaloid content for symphylan survival under greenhouse conditions

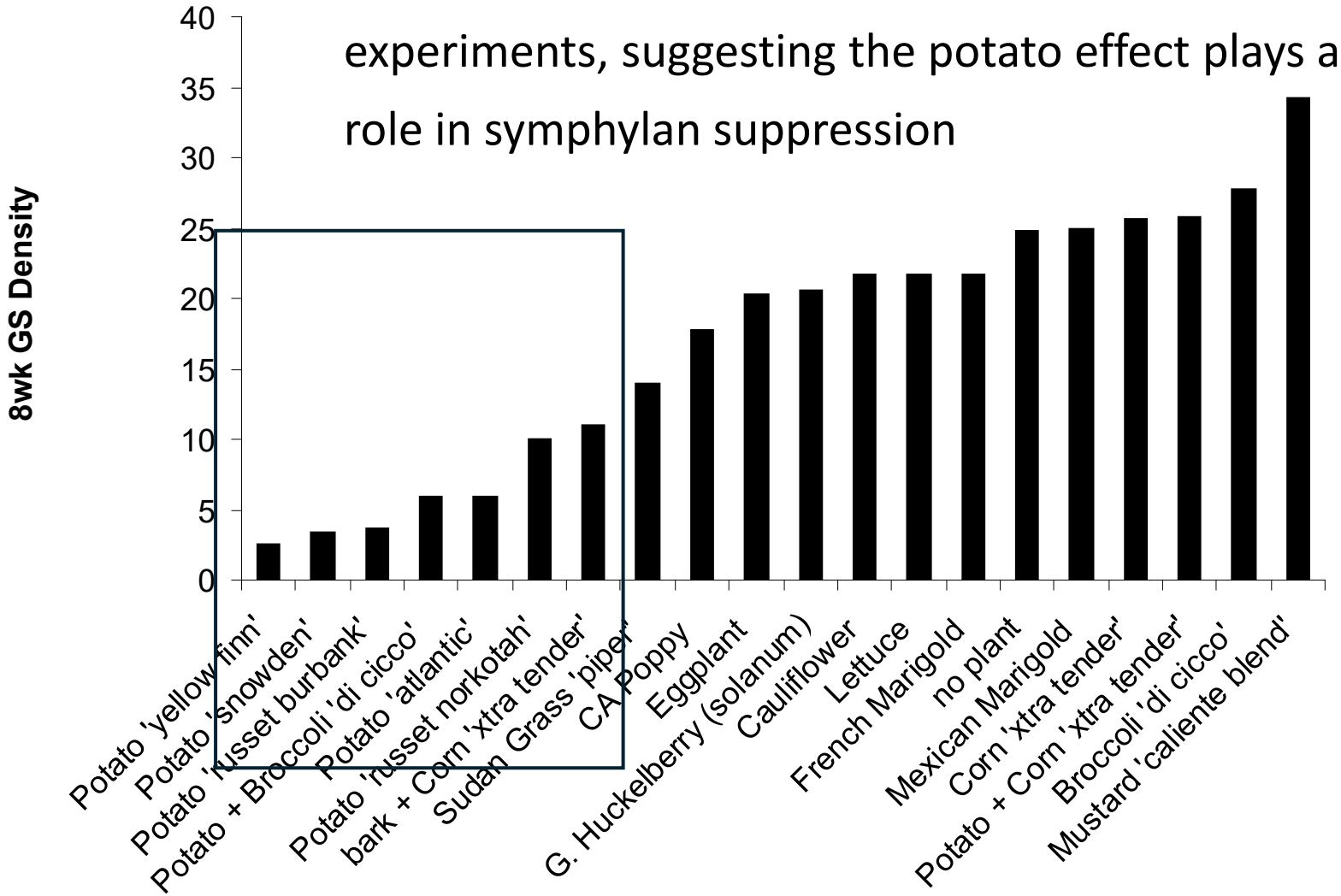
Earlier work at OSU (2000-2002)

- Over 40 crop species and/or varieties were screened over a two-year period in the greenhouse for activity against garden symphylans
- Treatments included varieties of annual ryegrass, barley, endophytic fescue, non-endophytic fescue, oats, orchardgrass, perennial ryegrass, potato and wheat
- Poor survival of symphylans on potatoes and cereal crops was observed



Potato Effect

- A similar trend was observed in a series of experiments, suggesting the potato effect plays a role in symphylan suppression



What is the Potato Effect?

- Glycoalkaloids (primarily solanine and chaconine) are natural, toxic compounds in potato tubers that act as a defense mechanism,
- Concentrated in the skin, sprouts, and eyes, and increase significantly with light exposure (greening), damage, or improper storage, causing a bitter taste and potential gastrointestinal or neurological toxicity
- Glycoalkaloid content in potato leaves and roots is higher than in the tubers

Table 1. Glycoalkaloid content in freeze-dried peeled potatoes and potato skin.

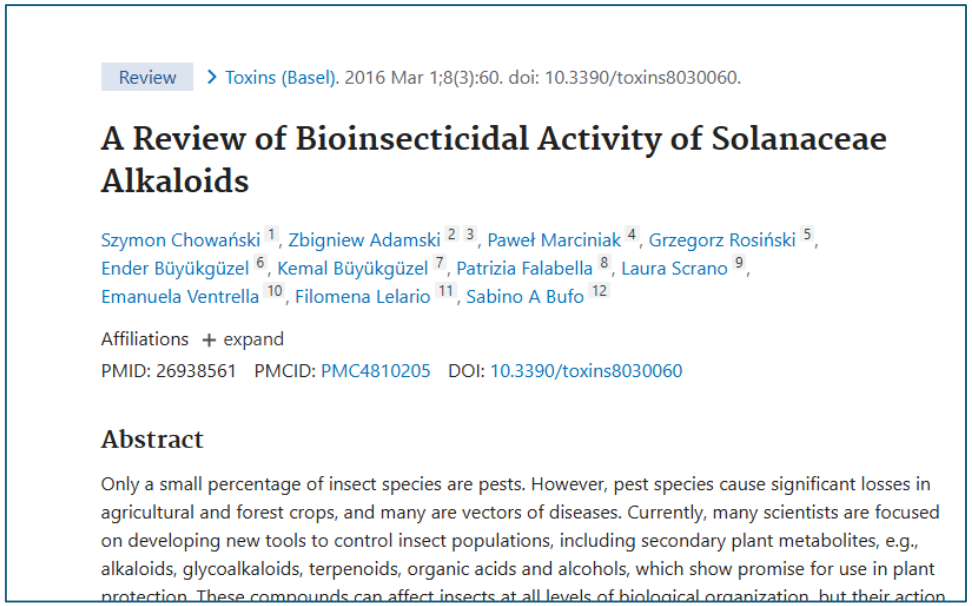
Cultivar	Glycoalkaloids content (mg/kg)*	
	Peeled tuber (fresh)	Peel
Ranger Russet	170	1,694
Russet Burbank	290	1,570
Russet Norkotah	94	996

*Sum of alpha chaconine plus alpha solanine

EM 9407 Glycoalkaloids In Potato Tubers

Glycoalkaloids and Toxicity to Herbivores

- Glycoalkaloids (e.g., **α-solanine** and **α-chaconine**) are well known for:
- Deterring herbivores
- Disrupting insect cell membranes and nervous systems
- Reducing feeding and survival in many insects



Review > Toxins (Basel). 2016 Mar 1;8(3):60. doi: 10.3390/toxins8030060.

A Review of Bioinsecticidal Activity of Solanaceae Alkaloids

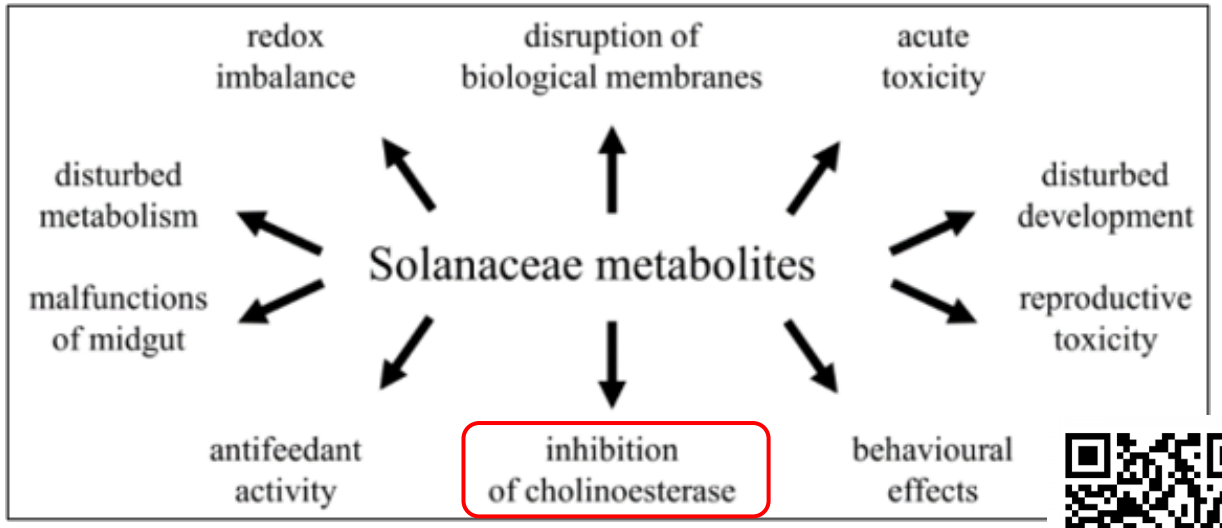
Szymon Chowański [1], Zbigniew Adamski [2 3], Paweł Marciniak [4], Grzegorz Rosiński [5], Ender Büyükgüzel [6], Kemal Büyükgüzel [7], Patrizia Falabella [8], Laura Scrano [9], Emanuela Ventrella [10], Filomena Lelario [11], Sabino A Bufo [12]

Affiliations + expand

PMID: 26938561 PMCID: PMC4810205 DOI: 10.3390/toxins8030060

Abstract

Only a small percentage of insect species are pests. However, pest species cause significant losses in agricultural and forest crops, and many are vectors of diseases. Currently, many scientists are focused on developing new tools to control insect populations, including secondary plant metabolites, e.g., alkaloids, glycoalkaloids, terpenoids, organic acids and alcohols, which show promise for use in plant protection. These compounds can affect insects at all levels of biological organization, but their action



Chowanski et al. 2016. Toxins

Are Glycoalkaloids Relevant to Symphylans?

- They are strong candidates for plant-mediated or soil-based suppression of symphylans:

- Because glycoalkaloids are present in roots and below-ground tissues

- Biologically active at low concentrations

- **High-glycoalkaloid potato lines** show reduced feeding and survival of some soil arthropods

Objective 1: Determining the direct effects of glycoalkaloids on symphylan survival

Step 1: Collected symphylans from the field

Step 2: Extracted symphylans from soil in lab

Step 3: Treated 0.75g of sprouts with the respective

Treatment:

- α-solanine and α-chaconine (Sigma Aldrich) mixed in a 2:3 ratio

  - Morris & Petermann, 1985

- Tested 0, 10, 100, and 1000 ppm

Results

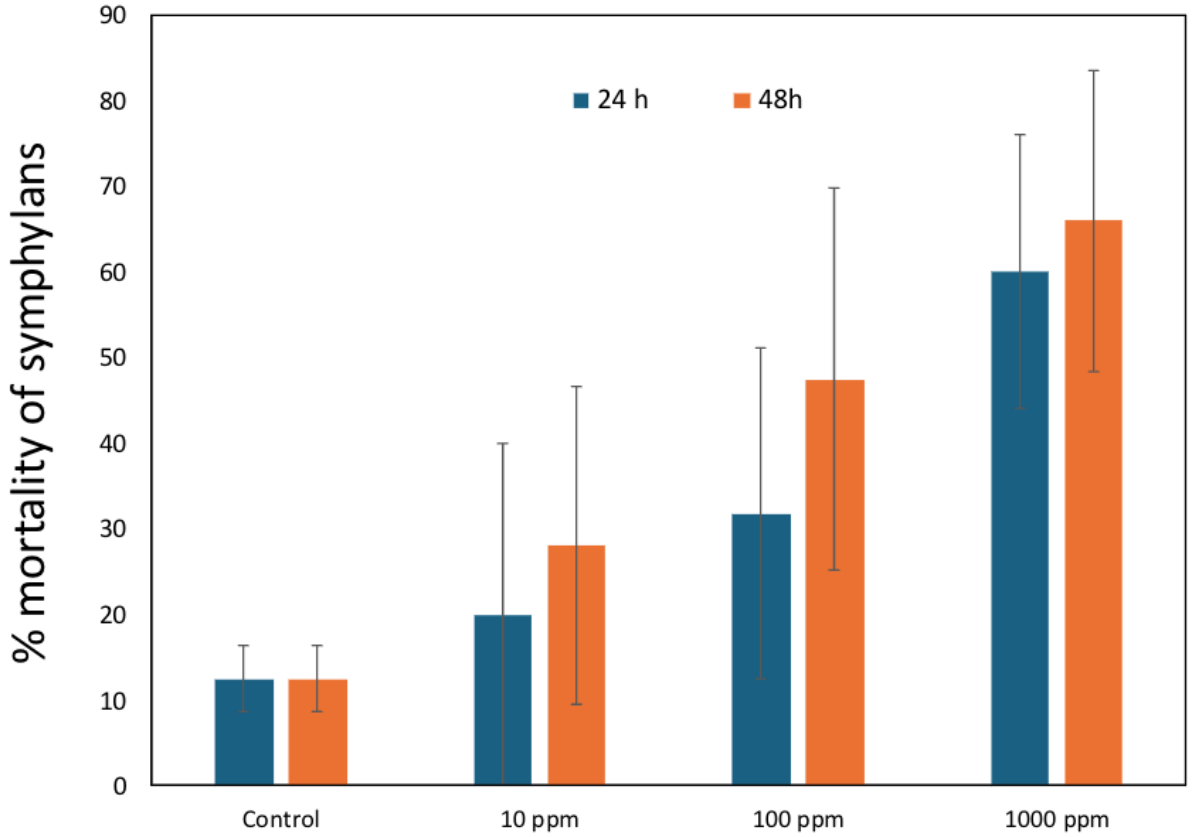
Mortality increased with glycoalkaloid concentration and exposure time

24 Hours:

- Mortality was highest in 1000 ppm
- Intermediate at 10 and 100 ppm

48 Hours:

- Increase mortality across all treatments
- 1000 ppm had the greatest mortality, to ~70%
- 10 and 100 ppm elevated intermediate response



Objective 2: Determining the suitability of solanaceous crops with high glycoalkaloid content for symphylan survival under greenhouse conditions

Step 1:

- Compile list of crop species and cultivars with distinct glycoalkaloid profiles

Species	Common name
Withania somnifera	Ashwagandha
Raphanus raphanistrum subsp. sativus	Daikon Radish
Solanum melanocerasum	Garden huckleberry
Solanum scabrum	Garden huckleberry
Physalis pubescens	Ground cherry
Cucurbita pepo	Ornamental gourds
Capsicum chinensea	Pepper - habanero
Capsicum chinense var. Mild Thing	Pepper - habanero
Capsicum annuum	Pepper - hot
Solanum tuberosum var. Snowden	Potato - high GA (Snowden)
Solanum tuberosum var. Yellow fin	Potato - low GA (Yellow Fin)
Physalis philadelphica & P. ixocarpa	Tomatillo
Solanum lycopersicum var. cerasiforme	Tomato - cherry
Solanum habrochaites	Wild hairy tomato

Objective 2: Determining the suitability of solanaceous crops with high glycoalkaloid content for symphylan survival under greenhouse conditions

Step 2:

Transplanted 3-4 week old plants into PVC pots

Step 3:

Repeated steps 1 and 2 from first objective

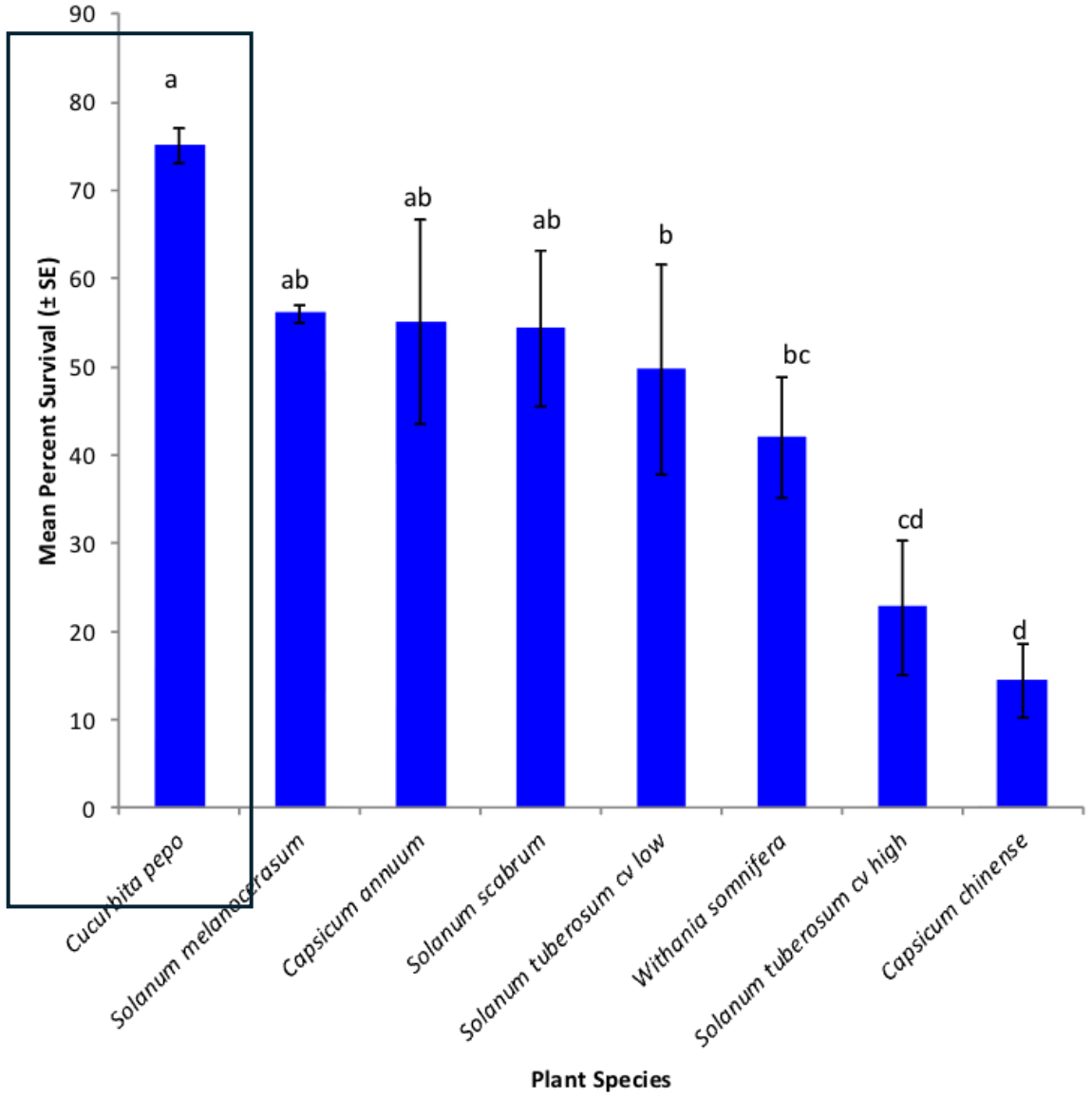
Step 4: Introduced 35 symphylans to treatment pots 1-2 weeks post transplant

- Continuous root

Step 5: After 28-30 days, weighed the foliar and roots and counted symphylans at 4-6 weeks

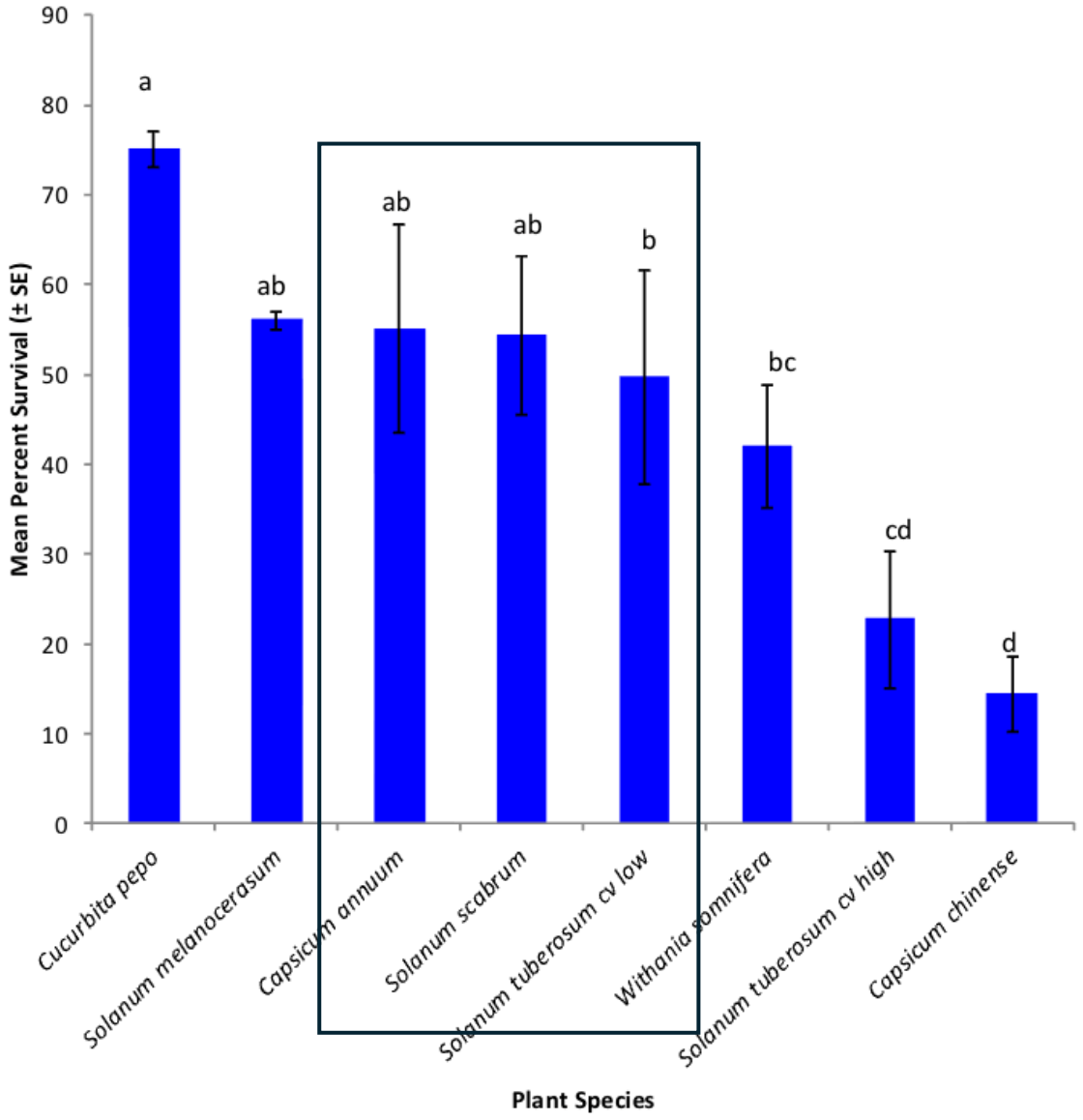
Results

- Symphylan survival differed among host plant species
  - <u>Highest survival:</u>
    - - *Cucurbita pepo* (Ornamental gourd) (75.0 ± 2.0%)



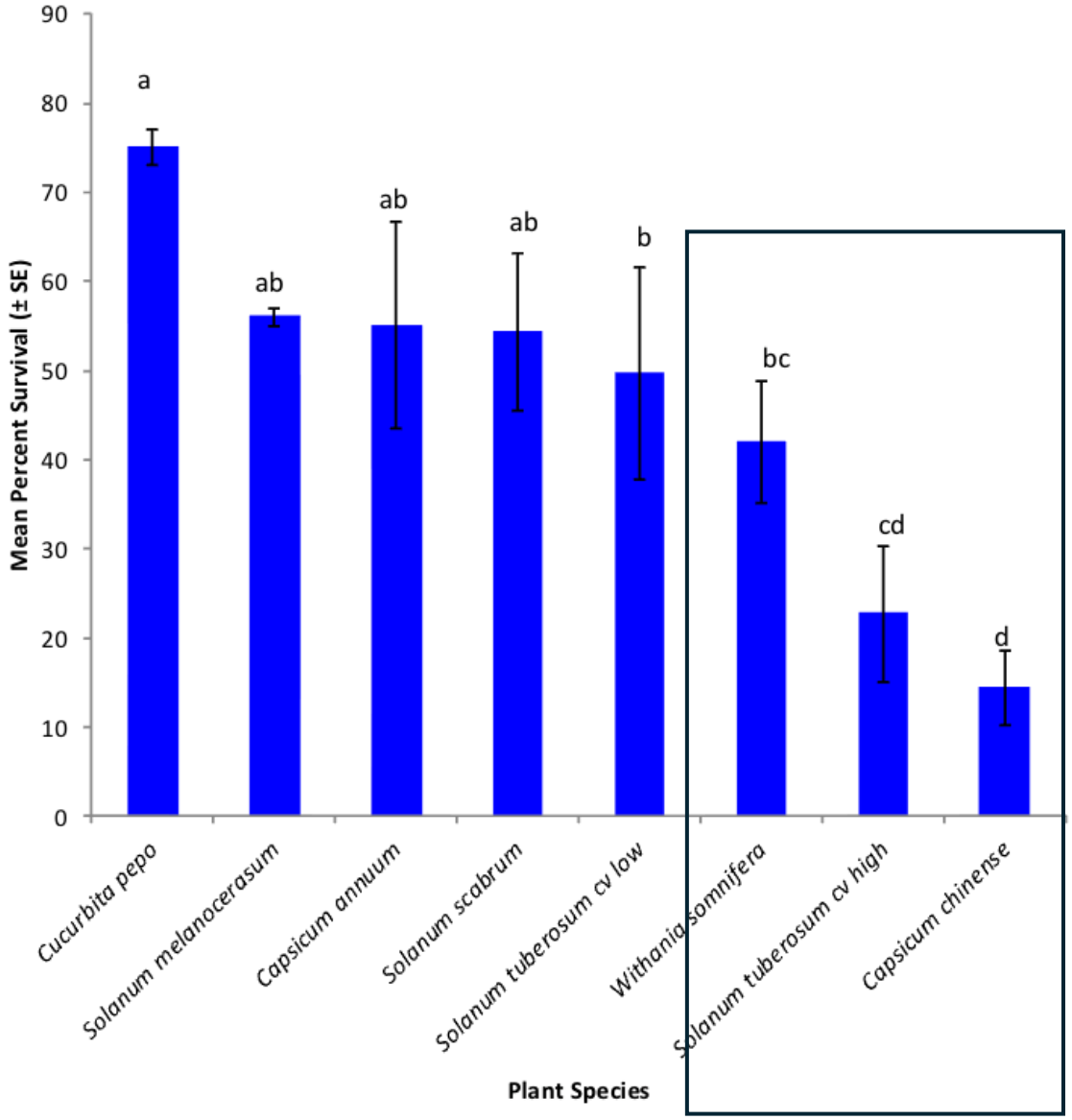
Results

- Symphylan survival differed among host plant species
  - <u>Intermediate survival:</u>
    - - *Capsicum annuum* (pepper),
    - - *Solanum melanocerasum* (garden huckleberry)
    - - Solanum *scabrum* (garden huckleberry)



Results

- Symphylan survival differed among host plant species
  - Further reduction:
    - - *Withania somnifera* (ashwagandha)
  - Lowest survival:
    - - *Solanum tuberosum* (high-glycoalkaloid potato cultivar)
    - - *Capsicum chinense* (habanero pepper)



Next Steps

- Plant tissues will be subjected to biochemical analyses to quantify concentrations of key secondary metabolites and relate chemical profiles to observed biological responses
- Data collection and statistical analyses are ongoing, and final conclusions will be refined upon completion of the study

Summary

- No single tactic provides consistent control; management must be integrated
- Biopesticides (such as Seduce® insect bait) reduced early symphylan pressure in some trials, supporting its role as a suppression tool
- Crop species and plant chemistry (e.g., glycoalkaloids) influence symphylan survival
- Monitoring for pest and natural enemies remain critical for effective risk management

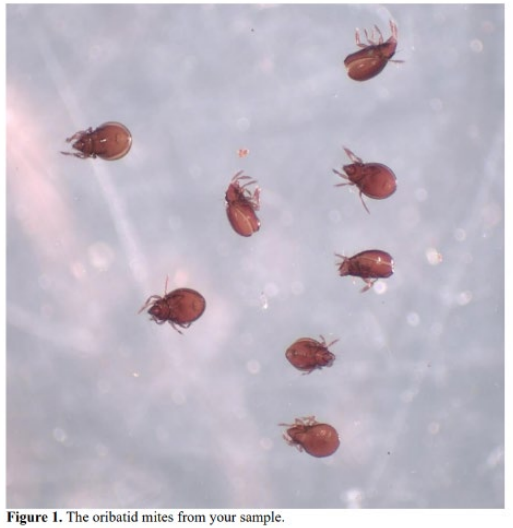


Figure 1. The oribatid mites from your sample.

Figure 2. The pergamasine mites from your sample.

Figure 3. Another view of the pergamasine mites.

Acknowledgments

- Funding by the WSARE, Oregon Processed Vegetable Commission, and the Specialty Seed Growers of Western Oregon
- Growers, Crop Consultants, and Fieldmen
- Technician, Field Crop Entomology Program, OSU