# The Secret of the Allelopathic Effect of Sunn Hemp for Suppressing Plant-parasitic Nematodes

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## Introduction

Biofumigation refers to the suppression of soilborne pests by biocidal compounds released into the soil during plant decomposition (Kirkegaard et al., 1993). Brassica plants have received the most attention in this area of research, but the possibility of using other plants as biofumigants warrants attention. Sunn hemp (*Crotalaria juncea*) is a good candidate for biofumigation research as it is well known to be a leguminous cover crop that releases nematostatic compounds (compounds that can paralyze nematodes) against many plant-parasitic nematodes (Wang et al., 2002). An article in the Summer 2011 issue of the Hānai'Ai Newsletter summarized the limitations and provided suggestions on ways to improve the use of sunn hemp as a cover crop for soil health and nematode management. This article summarizes factors that might affect the allelopathic effect of sunn hemp for suppressing plant-parasitic nematodes. A series of experiments was conducted to answer some questions frequently asked by farmers and gardeners. Specific objectives of this project were to examine the allelopathic effects of sunn hemp on root-knot nematode (*Meloidogyne incognita*) as affected by crop age, plant tissue, amount of sunn hemp biomass, *Crotalaria* species, and soil solarization.

## Materials and Methods

### Experiment I: Examine the effect of crop age, plant part, and amount of biomass

Sunn hemp tissues were collected at 1, 2, 3, and 4 months after planting and samples collected were separated to leaf, stem, flower, roots, or remained as whole plant. All tissues were oven dried (70°C for 2 days) and ground into powdered form (Fig. 1) prior to assay for allelopathic effect against root-knot nematodes. Ground powder was made into leachate by soaking in water, filtered, and each tissue type diluted into 0, 0.1, 0.5, 1 and 2.5 dilutions. Juveniles of


*Fig. 1. Sunn hemp flower, leaf and stem tissue ground up into powdered form for assay.*

*M. incognita* were introduced into each leachate dilution for 48 hrs to check for nematostatic effect and then transferred to water for another 24 hrs to examine if the nematodes could recover after removal from leachate (Fig. 2). Eggs of *M. incognita* were also incubated in each leachate dilution for a week and checked for egg hatch.

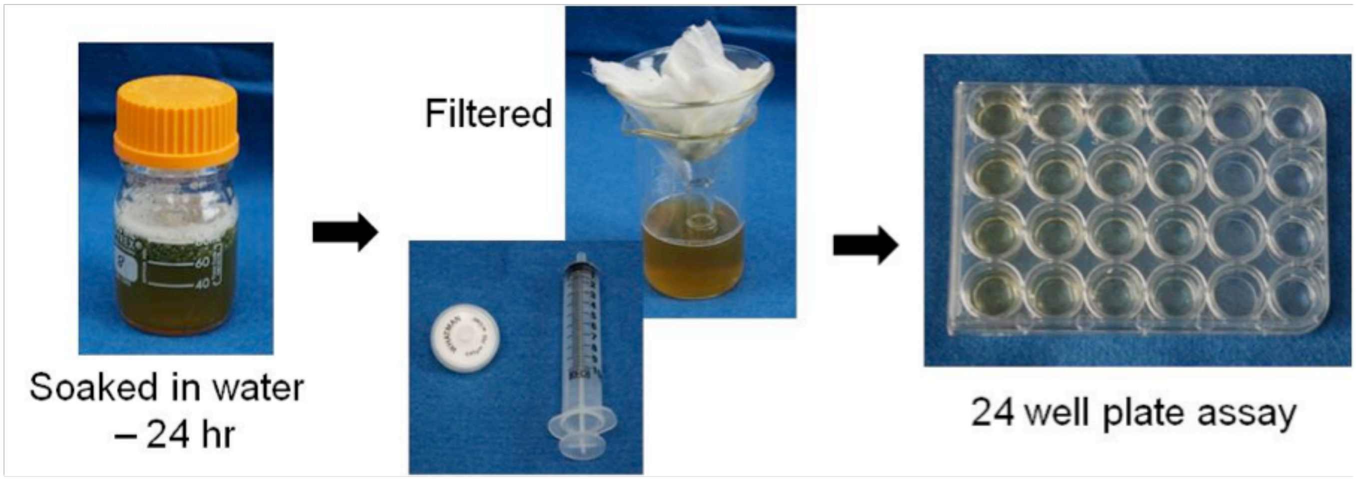


*Fig. 2. Sunn hemp tissues were prepared into leachate for nematode allelopathic assay.*

**Experiment II. Examine the effect of *Crotalaria* species**

To examine if sunn hemp is more effective than some of its relative weed species (*C. spectabilis* and *C. retusa*) for root-knot nematode suppression, 3-month old tissues of *C. juncea, C. spectabilis* and *C. retusa* were collected and prepared for allelopathic assay as described in Experiment I.

**Experiment III**

One question on the usage of sunn hemp is "Can we use sunn hemp as biofumigant in conjunction with soil solarization?" To answer this question, we prepared sunn hemp liter bags using the whole plant ground up and buried into the ground with and without solari-

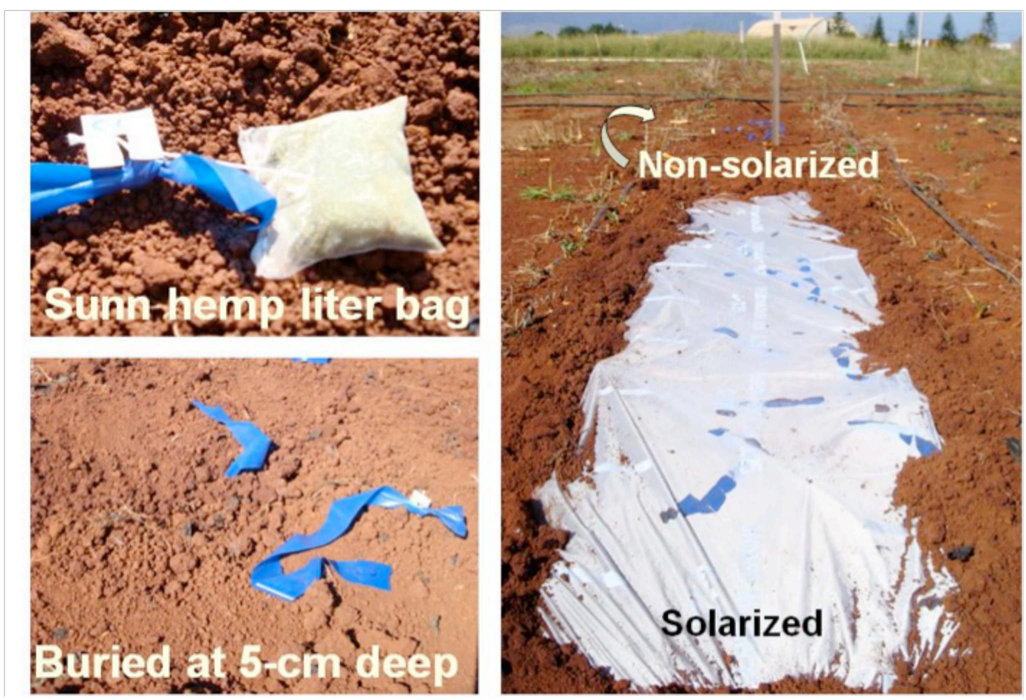


*Fig. 3. Sunn hemp tissue in liter bag was buried at 5-cm deep into the ground in solarized and non-solarized plots.*

zation mulch for 6 wks (Fig. 3). Sunn hemp tissue from these liter bags was assayed for allelopathic effect as described in Experiment I.

## Summary of Results

### 1. *What type of allelopathic effect did sunn hemp imposed on root-knot nematodes?*

Sunn hemp produces nematostatic effect on root-knot nematodes, which means that the allelopathic compound from sunn hemp only paralyzed the mobility of the nematodes when the nematodes were incubated in a concentrated form of sunn hemp leachate. Mobility of root-knot nematodes increased when the nematodes were transferred from the leachate to water solution. However in field conditions, once sunn hemp is incorporated into the soil, it is in a concentrated form unless the field is flooded. If the nematodes remain paralyzed over a long period of time, they will eventually starve to death.

### 2. *Which factors examined are most important for suppression of root-knot nematodes by sunn hemp?*

Among the three factors tested in Experiment I (age, tissue or biomass concentration), biomass concentration plays the most important role in suppressing root-knot nematodes. Overall, sunn hemp biomass needs to be > 0.1 % to suppress root-knot nematodes mobility. At 0.5, 1, and 2.5% concentration (equivalent to 2.5, 5, and 12.5 tons/acre dry biomass in the field, respectively), sunn hemp paralyzed 40, 60 and 90% of root-knot juveniles, respectively. During summer time in Hawaii, 5 tons/acre of dry sunn hemp biomass is easily achievable if planted at 30 lb seeds/acre in soil pH > 5 for 2 months.

Nematode suppressive effect of sunn hemp was also affected significantly by sunn hemp age (Fig. 4) and tissue part. Among sunn hemp crop age tested, 2- and 3-month old tissue suppressed > 75% of root-knot second stage juveniles (J2) mobility at lower concentration (0.5%) than the 1-month old tissue; whereas 4-month old tissue was least effective in suppressing J2 mobility. Among sunn hemp tissues, leaf and whole plant tissues paralyzed root-knot nematodes comparably and most effectively.

Allelopathic effect of sunn hemp on root-knot egg hatching is less remarkable as compared to its effects on J2 stage. At 2.5% concentration, 38% of root-knot eggs were still hatching.

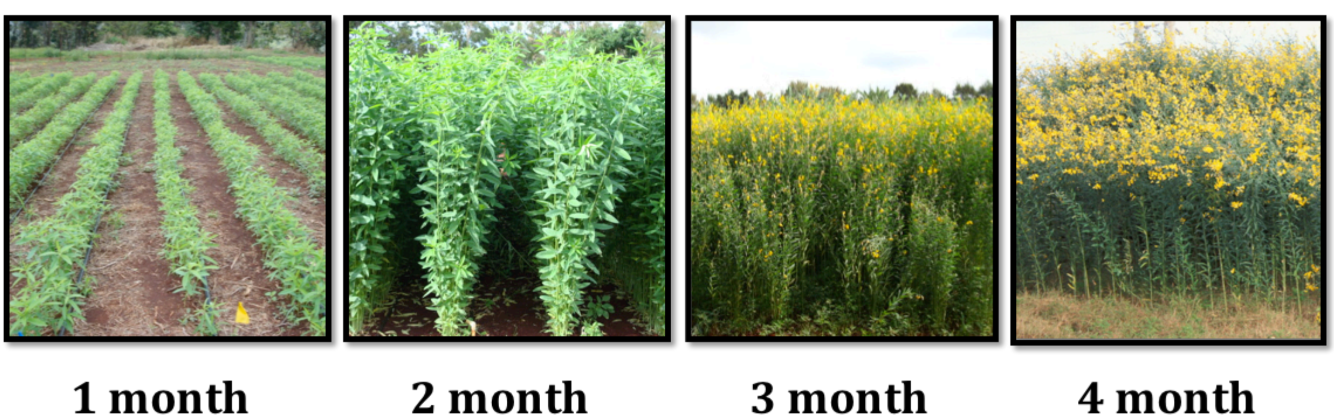


*Fig. 4. Sunn hemp at 1- to 4-month old.*

**3. *Is sunn hemp more effective than some of its relative weed species (C. spectabilis* and *C. retusa) for root-knot nematode suppression?***

Yes, sunn hemp is more effective in paralyzing J2 of root-knot nematodes than *C. spectabilis* and *C. retusa* (Fig. 5). Sunn hemp only required 0.5% of its leachate to suppress > 95 % of *M. incignita* J2, whereas *C. spectabilis* and *C. retusa* required 1 % and 2.5% concentration of their leachates to achieve similar levels of nematode suppression, respectively. In addition, based on our HPLC assays from these samples, sunn hemp as well as *C. retusa* did not contain monocrotaline which is a pyrrolizidine alkaloid found in *C. spectabilis* that is poisonous to livestock and humans (Wilson et al., 1992). Thus, sunn hemp has advatages over *C. spectabilis* and *C. retusa* as a cover crop for management of plant-parasitic nematodes.

*Fig. 5. Three species of Crotalaria (from left to right): C. juncea, C. spectabilis, and C. retusa.*

**4. *Does biofumigant effect of sunn hemp increase when used in conjunction with soil solarization?***

Soil solarization involves heating the soil beneath transparent polyethylene mulches for at least 4 weeks to elevate soil temperatures to levels detrimental to soilborne pests (Katan, 1981). Previously the author demonstrated that soil solarization suppressed weed pressure at early planting (Wang and Marahatta, 2009). The use of cruciferous residues (such as rapeseed) as soil amendments has been shown to enhance the effectiveness of solarization against soil-borne pathogens (Coelho *et al*., 2001) and nematodes (Ploeg and Stapleton, 2001). Unfortunately, previously the author demonstrated that integration of sunn hemp and soil solarization did not improve the nematode suppressive effect of sunn hemp alone (Wang et al., 2010; Marahatta et al., 2012). Current experiments demonstrate that solarization only slightly increased nematode suppressive effect of sunn hemp on root-knot J2 at lower concentration of sunn hemp leachate (0.1 and 0.5% concentrations) but not at higher sunn hemp concentration (1 and 2.5%).

## Conclusion

For best suppression of root-knot nematodes, sunn hemp should be planted for 2 to 3 months to achieve a biomass of at least 5 tons dry biomass/acre (equivalent to 1% concentration) and incorporated into soil. Incorporating sunn hemp materials that are too old will not suppress root-knot nematodes effectively. Leaf tissue is among the most suppressive component of sunn hemp against root-knot nematodes. Thus, incorporating sunn hemp at vegetative stage will be more effective in nematode suppression than at mature stage. Sunn hemp does suppress root-knot nematodes more efficiently than its weed relatives, *C. spectabilis* and *C. retusa*. Although, *C. spectabilis* is a common weed and has nematode suppressive effects, it contains monocrotaline, which is why it is considered a noxious weed that can harm livestock. It is not necessary to integrate soil solarization with sunn hemp cover cropping for nematode suppression as long as the cover crop could produce > 5 tons dry biomass/acre for soil amendment. However, soil solarization could reduce initial population densities of weed pressure.

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