RESEARCH NOTE/NOTA DE INVESTIGACIÓN

EFFECTS OF SUNN HEMP FOLIAGE AND MACADAMIA NUT HUSKS ON PLANT-PARASITIC AND BENEFICIAL NEMATODES

V. H. Henmi and S. P. Marahatta*

Plant Biology and Tropical Agriculture Program, Science and Math Division, Kaua`i Community College, University of Hawai`i, 3-1901 Kaumualii Highway, Lihue, HI 96766, USA; *Corresponding author: sharadch@hawaii.edu

ABSTRACT

Henmi, V. H., and S. P. Marahatta. 2018. Effects of sunn hemp foliage and macadamia nut husks on plant-parasitic and beneficial nematodes. Nematropica 48:34-37.

Sunn hemp, *Crotalaria juncea*, foliage (SH) has been documented as a soil amending material for controlling multiple plant-parasitic nematodes such as root-knot nematodes, *Meloidogyne* spp., and burrowing nematode, *Radopholus similis*, and enhancing beneficial free-living nematodes. In Hawai‘i the macadamia nut, *Macadamia integrifolia*, husk (MN) as a mulch and soil amending material is used in areas with macadamia orchards. MN compost improves soil health in sub-tropical horticulture by increasing microbial activity, water holding capacity, pH, carbon, and nitrogen. SH and MN amendments were compared to non-amended soil (CC) to determine effects on *Meloidogyne*, *R. similis*, and beneficial nematodes through two laboratory experiments. In both experiments, banana orchard soil infested with *R. similis* and *Meloidogyne* were sampled. In both experiments, SH consistently showed the highest number of beneficial nematodes ($P<0.05$) and the lowest populations of *R. similis*. The effects of SH on *Meloidogyne* were not observed in Experiment-I. However, in Experiment-II, no *Meloidogyne* were found in SH. Compared to CC and SH, MN did not increase beneficial nematode numbers ($P>0.05$), nor reduce *R. similis* and *Meloidogyne* populations ($P > 0.05$). Researchers and Hawaiian farms should compare the effects of SH and MN on *Meloidogyne* and *R. similis* and beneficial nematodes under field conditions.

Key words: *Crotalaria juncea*, *Macadamia integrifolia*, *Meloidogyne*, *Radopholus similis*

RESUMEN

Henmi, V. H., y S. P. Marahatta. 2018. Efectos de follaje de cáñamo sunn y cáscaras de nuez de macadamia en nemátodos parásitos y beneficiosos de plantas. Nematropica 48:34-37.

Se ha documentado que el cáñamo de Bengala, *Crotalaria juncea*, follaje (SH) es un material modificador del suelo para controlar nematodos parásitos de plantas múltiples como nematodos agalladores, *Meloidogyne* spp. y nematodos barrenadores, *Radopholus similis*, y mejora de nematodos benéficos de vida libre. En Hawaii, el uso de nuez de macadamia, *Macadamia integrifolia*, cáscara (MN) como mantillo y material de modificación del suelo se usa en áreas con huertos de macadamia. El compost MN mejora la salud del suelo en la horticultura subtropical al aumentar la actividad microbiana, la capacidad de retención de agua, el pH, el carbono y el nitrógeno. Las enmiendas SH y MN se compararon con suelo no modificado (CC) para determinar los efectos sobre *Meloidogyne*, *R. similis* y nematodos beneficiosos a través de dos experimentos de laboratorio. En ambos experimentos, se muestrearon suelos de banano infestados con *R. similis* y *Meloidogyne*. En ambos experimentos, SH mostró consistentemente el mayor número de nematodos beneficiosos ($P<0.05$) y las poblaciones más bajas de *R. similis*. Los efectos de SH en *Meloidogyne* no se observaron en el Experimento-I. Sin embargo, en el Experimento II, no se encontraron *Meloidogyne* en SH. Comparado con CC y SH, MN no aumentó el número de nematodos beneficiosos ($P>0.05$), ni redujo las poblaciones de *R. similis* y *Meloidogyne* ($P>0.05$). Los investigadores y granjas Hawaianas deben comparar los efectos de SH y MN en *Meloidogyne* y *R. similis* y los nematodos beneficiosos en condiciones de campo.

Palabras claves: Crotalaria juncea, *Macadamia integrifolia*, *Meloidogyne*, *Radopholus similis*

The plant-parasitic burrowing nematode, *Radopholus similis*, and root-knot nematode, *Meloidogyne* spp., are harmful to banana in Hawaii 34(Wang and Hooks, 2009). Beneficial nematodes are important to soil nutrient cycling and soil health improvement (Wang and McSorley, 2005). Nematode management for Hawaiian banana should include a strategy for reducing *R. similis* and *Meloidogyne*, along with increasing the beneficial nematode population.

Sunn hemp (SH), *Crotalaria juncea*, is a tropical cover crop. The foliage of sunn hemp, after incorporation into the soil, releases an allelopathic compound, monocrotaline (Rodriguez-Kabana *et al*., 1992; Wang *et al*., 2001; Wang *et al*., 2002; Jourand *et al*., 2004). SH suppresses plant-parasitic nematodes and enhances beneficial nematodes (Wang *et al*., 2011). Continuous planting of SH may lead to wilting problems caused by flour beetles (*Tribolium castaneum*). Therefore, it is not advisable to rely exclusively on SH as a cover crop.

The husks of macadamia nut, *Macadamia integrifolia* (MN), could be used as another option for nematode control. MN are rich in carbon (Ahmadpour and Do, 1997; Cox *et al*., 2004) and carbon amendment to the soil reduces plant-parasitic nematodes (Browning *et al*., 1999). Nematode reducing mechanism of carbon is not clear. However, Browning *et al*. (1999) had hypothesized that carbon amendment could increase the population of fermentative soil bacteria and the bacteria could reduce nematode density. Furthermore, MN contains cyanogenic compounds that release hydrogen cyanide (HCN) on hydrolysis (Dahler *et al*., 1995). The objective was to compare the effects of SH and MN on *R. similis* and *Meloidogyne* spp. suppression and beneficial nematode enhancement.

Two laboratory experiments (I and II) using MN and SH were conducted at Kaua‘i Community College, Lihue, HI, in Spring 2015. In Experiment-I and -II, *R. similis* and *Meloidogyne* spp. infested soil was collected from a banana field at S & F Takahashi Farm, Kalaheo, Kaua‘i, HI. Collected soil was reddish clay loam, Oxisol. Soil was placed into 12, 7.62-cm-diam. pots. Each pot was filled with 300 cm^3 soil and immediately amended with 1% (w/w) SH, MN, or not amended (CC). SH foliage powder and MN husk powder used for soil amendment were prepared from SH plants grown at Kaua‘i Community College Farm and MN plants grown at S & F Takahashi Farm, respectively. SH and MN were oven-dried and ground to a powder with a commercial blender (Winsted Conn, Waring Products Co., CT) prior to incorporation, as practiced by previous researchers (Marahatta *et al*., 2012; Henmi and Marahatta, 2015). Each experiment was replicated four times and arranged in a randomized complete block design (RCBD) in the shadehouse.

Soil (100 cm^3/pot) was sampled for nematodes at amendment (Pi) and termination (Pf) of experiment using the Baermann funnel technique. Extracted nematodes were counted at 40× magnification with the aid of an inverted microscope.

Data were subjected to one-way analysis of variance (ANOVA) using the general linear method (GLM) procedure in Statistical Analysis System (SAS Institute, Cary, NC). Nematode numbers were log-transformed [log (x+1)] prior to ANOVA to normalize data. Untransformed arithmetic means of data are presented. Means were separated using a Waller-Duncan κ-ratio (κ=100) *t*-test.

Compared to SH, CC and MN did not reduce the Pf of *R. similis* (P>0.05) (Fig. 1). In both experiments, the population of *Meloidogyne* was low (0, 0, 2 in experiment-I, and 3, 2, 0 in experiment-II in CC, MN, SH, respectively). Treatment effects on *Meloidogyne* were not found (P>0.05). Consistently higher numbers of beneficial nematodes were found in the SH treatment (P <0.05) (Fig. 2). Beneficial nematodes comprised bacterivorous, fungivorous, omnivorous and predaceous species (data not presented). The

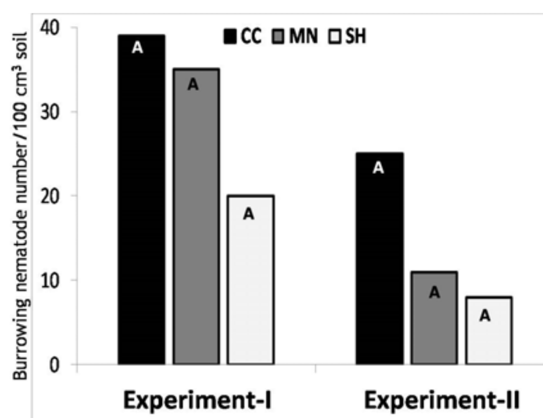

Fig. 1. The effects of sunn hemp (SH) and macadamia nut husks (MN) soil amendment and no amendment (CC) on abundance of burrowing nematodes, *Radopholus similis*. Means are average of 4 replications. Means followed by same letter(s) in each experiment do not differ according to Waller-Duncan κ-Ratio (κ = 100) t-test based on log(x+1) transformed value.

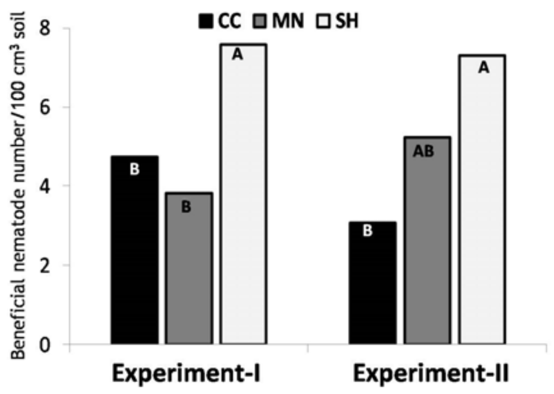

Fig. 2. The effects of sunn hemp (SH) and macadamia nut husks (MN) soil amendment and no amendement (CC) on abundance of beneficial nematodes. Means are average of 4 replications. Means followed by same letter(s) in each experiment do not differ according to Waller-Duncan κ-Ratio (κ = 100) t-test based on log(x+1) transformed value.

most dominant beneficial nematode was *Rhabditis* spp. Other frequently observed beneficial nematodes were *Cephalobus*, *Eucephalobus*, *Aphelenchoides*, *Aphelenchus*, *Mesodorylymus*, *Mononchus*, and *Prismatolaimus* (data not presented). Finding more beneficial nematodes in SH is consistent with the previous experiments, where SH was incorporated into field soils (Wang *et al*., 2011). SH showed a consistent trend of lower abundance of *R. similis* in both experiments and in populations of *Meloidogyne* in experiment-II than CC. These results are not consistent with earlier findings where SH reduced *Meloidogyne* spp. (Wang *et al*., 2002; Wang *et al*., 2011). This might be due to the lower Pi of *Meloidogyne* and *R. similis* in experimental soils. Thus, current results indicate that SH could be ineffective when populations of *R. similis* and *Meloidogyne* are low.

MN amendment was not effective in reducing plant-parasitic nematodes or increasing beneficial nematodes. The concentration of releasable cyanide is much lower in tissues of mature nuts than in the early developmental stages beginning at germination of MN (Dahler *et al*., 1995). Moreover, Dahler *et al*. (1995) measured a lower concentration (0.15 μmol/g fresh weight) of cyanide in cotyledons of edible MN, *M. integrifolia*, and a higher concentration (9.6 μmol/g) in non-edible MN, *M. ternifolia*. The use of *M. integrifolia* nut husks in the current experiment might be a reason for no effects against nematodes.

Until further research is done on the cyanide in MN for nematode control, SH foliage should be selected over MN husk as a plant-parasitic nematode suppressant.

ACKNOWLEDGMENT

This project was supported by grants from the National Institute of Food and Agriculture, U.S. Department of Agriculture (NIFA, USDA) (award number 2016-38426-25614), the National Center for Research Resources (5P20RR016467-11), and the National Institute of General Medical Sciences (8P20GM103466-11) from the National Institutes of Health (NIH). The content is solely the responsibility of the authors and does necessarily represent the official views of the NIFA nor NIH.

LITERATURE CITED

Ahmadpour, A., and D. D Do. 1997. The preparation of activated carbon from macadamia nutshell by chemical activation. Carbon 35:1723-1732.

Browning, M., C. Dawson, S. R. Alm, C. F., McFlderrey, and J. A. Amador. 1999. Effect of carbon amendment and soil moisture on *Tylenchorhynchus* and *Hoplolaimusgaleatus*. Journal of Nematology 31:445-454.

Cox, J., L. Van-Zwieten, M. Ayres, and S. Morris. 2004. Macadamia husk compost improves soil health in sub-tropical horticulture. Proceedings of the 3rd Australian New Zealand Soils Conference, 5–9 December, University of Sydney, Australia. Published on CDROM. Website www.regional.org.au/au/asssi/

Dahler, J. M., C. Mcconchie, and C. G. N. Turnbull. 1995. Quantification of cyanogenic glycosides in seedlings of three macadamia (Proteaceae) species. Australian Journal of Botany 43:619-628.

Henmi, V. H., and S. P. Marahatta. 2015. Impacts of sunn hemp and pigeon pea on plant-parasitic nematodes, *Radopholus similis* and *Meloidogyne* spp., and beneficial bacterivorous nematodes. International Journal of Phytopathology 4:29-33.

Jourand P., S. Rapior, M. Fargette, and T. Mateille. 2004. Nematostatic activity of aqueous extracts of West African *Crotalaria* species. Nematology 6:765–771.

Marahatta, S. P., K.-H. Wang, B. S. Sipes, and C. R. R. Hooks. 2012. Effects of *Crotolaria juncea* on anhydrobiotic state of *Rotylenchulus reniformis*. Nematropica 42:34-40.

Rodriguez-Kabana R., J. Pinochet, D. G. Robertson, C. F. Weaver, and P. S. King. 1992. Horsbean (*Canavalia ensiformis)* and crotalaria (*Crotalaria spectabilis*) for the management of *Meloidogyne* spp. Nematropica 22:29–35.

Wang, K.-H., B. S. Sipes, and D. P. Schmitt. 2001. Suppression of *Rotylenchulus reniformis* by *Crotolaria juncea*, *Brassica napus*, and *Tagetes erecta*. Nematropica 31:237–251.

Wang, K.-H., B. S. Sipes, and D. P. Schmitt. 2002. Crotolariaas cover crop for nematode management: A review. Nematropica 32:35-57.

Wang, K.-H., and R. McSorley. 2005. Effects of soil ecosystem management on nematode pests, nutrient cycling, and plant health. APSnet Features. doi: 10.1094/APSnetFeatures/2005-0105, St. Paul, MN. http://www.apsnet.org/publications/apsnetfeatures/Pages/SoilEcosystemManagement.aspx (6 September 2010).

Wang, K.-H., and C. R. R. Hooks. 2009. Plant-parasitic nematodes and their associated natural enemies within banana (*Musa* spp.) plantings in Hawaii. Nematropica 39:57-73.

Wang, K.-H., C. R. R. Hooks, and S. P. Marahatta. 2011. Can a strip-till cover cropping system followed by surface mulch practice enhance organisms higher up in the food web hierarchy? Applied Soil Ecology 49:107-117.

Received: 31/VII/2017

Accepted for Publication: 16/IX/2017

Recibido:

Aceptado para publicación: