Effect of Weed Control Methods on Soil Invertebrate Community in Cinnamon (*Cinnamomum zealanicum* Blum) Ecosystem

I.D.M. Buddhika, H.M.S.K. Herath
Uva Wellassa University, Badulla, Sri Lanka

and

G.G. Jayasinghe
Cinnamon Research Station, Palolpitiya, Matara, Sri Lanka

Introduction

Cinnamon is an important perennial spice crop, which is grown commercially mostly along the coastal belt from Negambo to Matara, and in areas such as Kalutara and Ratnapura. Various agronomic practices are associated with the cinnamon cultivation and weed control is one of those. Methods such as chemical weeding (Glyphosate), mammoty weeding and slash weeding are the popular weed control practices. Soil invertebrates are defined as the organisms without backbone. Soil invertebrates can have different impacts on land productivity. Their community can be altered with different agronomic practices especially weed control. Therefore, this research was conducted to examine the effect of different weed control methods on soil invertebrate community in cinnamon cultivation.

Methodology

The study was conducted at Cinnamon Research Station, Palolpitiya, Matara (6˚ 01' 38" N, 80˚ 33' 36" E, 47 m)as three experiments during the period of June – August, 2013. The first experiment was conducted to identify the soil invertebrates which are found in cultivated cinnamon lands for many years. Five trials were undertaken using five soil samples taken from different places in the cultivated cinnamon land. The soil invertebrates were extracted to a reagent bottle with 70% ethyl alcohol using modified Berlese funnel extractors. Extracted soil invertebrates were observed under the stereo microscope and identified using a dichotomous key. The second experiment was conducted to determine the effect of three different weed control methods (mammoty weeding, chemical weeding and slash weeding) with a control (no weed control) on soil invertebrate community in cinnamon cultivation. Three plots, in which three different weed control methods practiced were selected and tested consecutively for three months as the main treatments. Three different levels of soil depths (1-10, 11-20 and 21-30 cm) with litter layer as the sub treatments with three replicates were assigned in split-plot design. Soil invertebrates were extracted from 412cm ^{3}soil sample using modified Berlese funnel extractors, observed through stereo microscope, identified using a dichotomous key and counted the number of individual in each soil invertebrate orders. Data were subjected to ANOVA using SAS package. The third experiment was carried to ascertain the relationship between soil invertebrates with selected soil properties and rainfall. Selected soil properties were tested according to the standard methods. Soil bulk density was tested using core sampler method on dry basis and soil moisture content was determined using gravimetric method. Soil organic matter content was tested according to Walkey and Black method and soil pH was determined using pH meters. Monthly rain fall data were recorded in a rain gauge fixed in Cinnamon Research Station. The relationships were tested by correlation analysis using SAS package.

Results and Discussion

Different groups of soil invertebrates were identified in the soil where cinnamon had been cultivated for several years. Mites (31%) and Collembolans (26%) were the most abundance soil invertebrates groups found in cinnamon ecosystem. Although ants, termites, isopods and earth worm were also common groups, diplura, protura, symphyla, millipedes, and centipedes groups

were scarce in the selected cinnamon field. No weed control and the slash weeding treatments have showed significantly higher abundance and diversity soil invertebrates than mammoty and chemical weeding. Highest earthworm population was observed in no weeding plot followed by slash weeding and mammoty weeding. Collembolan, mites and other invertebrates were statistically same and significantly higher in slash weeding and no weeding plots than mammoty weeding and chemical weeding (Table 1).

Table 1. Mean number of soil invertebrates (412cm ^{3} of soil) on different weed control methods.

Treatment	Abundance	Diversity	Earthworm	Collembolan	Mites	Other
No weeding	21.250 a	4.916 a	0.416 a	8.5833 a	10.333 a	0.6667 a
Mammoty weeding	7.000 b	2.083 b	0.083 bc	2.4167 c	1.500 c	0.1667 b
Chemical weeding	3.250 c	1.500 b	0.000 c	2.4167 c	1.500 c	0.0833 b
Slash weeding	18.583 a	4.250 a	0.333 ab	3.5833 b	5.417 b	0.6667 a
P value	0.0001	0.0001	0.0002	0.0001	0.0001	0.0054
CV	27.570	26.012	44.222	33.137	51.4344	89.318
LSD	2.908	0.698	0.2532	1.1168	2.2752	0.9394

Within a column, the means followed by the same letter are not significantly different at p=0.05.

According to Hendrix et al. (1986) soils with no tillage tend to create more favorable micro habitat for soil organisms and it improves the diversity of the soil macro fauna. Similar trends could be seen in the present study as slash weeding and no weed control plots were shown higher diversity and abundance of soil invertebrates than the mammoty weeding and chemical weeding. Chemical weed control gradually decreased the soil invertebrates' diversity with the time while slash, mammoty and no weeding did not shown such a trend in soil invertebrates' diversity and abundance. Similar results were observed by French and Buckley (2006). But according to Haughton *et al.* (2001), there was a significant effect of glyphosate on soil invertebrate abundance such as spiders after four months of follow chemical application. Mostly the soil organisms occur in the top 30 cm of soil, although some occur at depth. In this study also (Table 2), mostly soil invertebrates were concentrated in the soil litter and 0-10cm depth of soil from the surface.

Table 2. Mean number of soil invertebrates (412cm $^{-3}$ g of soil) on different soil depths.

Treatment	Abundance	Diversity	Earthworm	Collembolan	Mites	Other
Litter	19.250 a	4.916 a	0.000 b	4.166 b	9.667 a	0.500 a
0-10	21.583 a	4.583 a	0.666 a	8.083 a	6.417 b	0.500 a
11-20	8.000 b	2.583 b	0.166 b	3.250 b	3.917 c	0.500 a
21-30	1.250 c	0.666 c	0.000 b	0.500 c	1.000 d	0.0833 b
P value	0.0001	0.0001	0.0002	0.0001	0.0001	0.0054
CV	27.57047	26.012	44.222	33.137	51.4344	89.31875
LSD	2.9086	0.6986	0.2532	1.1168	2.2752	0.9394

Within a column, the means followed by the same letter are not significantly different at p=0.05.

No any significant relationship (p>0.05) was observed between rainfall and abundance or diversity of the soil invertebrates' community during the study period.

Only a significant negative relationship was observed between soil bulk density with soil invertebrates' diversity and abundance (Table 3). This negative relationship was stronger for

diversity than for the abundance. However no any significant correlation ($p>0.05$) was observed between other soil characteristics and the soil invertebrates during the study period.

Table 3. Relationship of the soil invertebrate's abundance and diversity with the selected soil properties.

	OM		pH	BD	MC
Abundance	Correlation co-efficient	-0.10296	0.02694	-0.3759	0.17188
	Probability*/**/***	0.5502	0.8761	0.0239*	0.3162
Diversity	Correlation co-efficient	0.02028	-0.01259	-0.53404	0.42683
	Probability*/**/***	0.9065	0.9419	0.0008***	0.8048

Conclusions

The study concludes that slash weeding is the least destructive weed control method in cinnamon cultivation in the aspects of soil invertebrates. Most of the soil invertebrates could be found in litter layer and 1-10 cm layer. There is a negative relationship between soil bulk density and abundance of soil invertebrates and diversity of soil invertebrates. However there is no relationship between soil invertebrates community and rain fall in relation 3 months of experimental time period.

References

French, K., Buckley, S., 2007. The effect of the herbicide metsulfuron-methyl on litter invertebrate communities in a coastal dune invaded by *Chrysanthemoidesmonilifera* spp. *rotundata*. Weed Research, 48, 266-272.

Lavelle, P., Decaëns, T., Aubert, M., Barot, S., Blouin, M., Bureau, F., Margerie, P., Mora, P., Rossi, P., 2006. Soil invertebrates and ecosystem services. European Journal of Soil Biology, 42(1), 3–15.

Haughton , A.J., Bell, A.J., Wilcox, A., Boatman, N.D., 2001. The effect of the herbicide glyphosate on non-target spiders: Indirect effects on *Lepthyphantes tenuis* in field margins. Pest Management Science, 57(11), 1037-1042.

Hendrix, P.F., Parmelee, R.W., Crossley, D.A., Coleman, D.C., Odum, E.P., Groffman, P. M., 1986. Detritus food webs in conventional and no-tillage agro-ecosystems. Bioscience, 36(6), 374-380.