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RESEARCH PAPER

Effect of cover crops on the diversity and nematode community in Naawan, Misamis Oriental

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Key words: Cover crops, Diversity, Nematodes, Community structure, Philippines

Abstract

Cover crop management plays a significant role in regulating soil faunal composition. The structure of the soil nematode community, including abundance, diversity, and ecological indices, was compared across different plots of perennial plants, *Arachis pintoi,* and *Sphagneticola trilobata*, in a field experiment in Naawan, Misamis Oriental, Philippines. The soil was sampled 90 days after planting to assess nematode populations. Nematodes were then counted and identified up to the genus level. Additionally, nematode-based indices were used to evaluate the condition of the soil food web. The findings reveal that cover crops increased the nematode abundance from 1427 to 1451 individuals per 100 g, and diversity increased from 59 to 68 genera. Trophic groups, fungivores, and herbivores groups significantly changed. The *A. pintoi* plot also caused a 35% decrease in the overall herbivore group after 90 days of planting, whereas *S. trilobata* showed the lowest decrease. Sensitive genera belonging to cp 3 and 4 have increased only in *A. pintoi,* indicating a favorable soil food web condition among all cover crop treatments. Among the indices utilized, the structural index showed an immediate response to short-term investigation of the cultivation of cover crops. These findings provide valuable information for the limited cover crop studies in the Philippines. This study was conducted briefly; hence, other indices used may provide substantial evidence if the experiment is prolonged.

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Introduction

A soil ecosystem is a complex habitat for various organisms, including thousands of microfauna, mesofauna, and macrofauna (Ponge, 2015). These organisms are crucial in improving soil fertility by breaking down plant and animal matter, releasing stored nutrients, and converting them into forms that plants can use (Sylvain and Wall, 2011). The dynamics of the soil ecosystem are influenced by soil organisms, making the status of the soil food web a crucial consideration in sustainable land management (Bünemann *et al.*, 2018). Soil organisms, especially nematodes, serve as valuable indicators of soil quality due to their rapid response to changes in soil management (Sánchez-Moreno and Ferris, 2018). Knox *et al.* (2003) found that nematodes play a crucial role in regulating soil microbial communities and increasing microbial colonization through grazing on soil. Nematodes act as both predator and prey, providing valuable information about the abundance and activity of other soil organisms. Thus, nematodes are helpful indicators in studying soil food web conditions, biodiversity, and ecosystem functioning (Bongers and Bongers, 1998; Bongers and Ferris, 1999; Neher, 2010). Nematodes, occupying various levels in the soil food web, are categorized based on their food sources, such as bacterivores, fungivores, herbivores, omnivores, and predators, making them commonly used as biological indicators (Hua *et al.*, 2021). Soil nematode community descriptors such as abundance, number of genera, and nematode-based indices have been used to assess the impact of soil management practices across agroecosystems (Ito *et al.*, 2015). Changes in the occurrence and abundance of different nematode-feeding groups are often associated with changes in crop species and soil management practices (Krashevska *et al.*, 2019). Shifts in nematode communities can signify changes in soil and ecological processes, including nutrient cycling, organic matter decomposition, and the balance of soil food webs (Ankrom *et al.*, 2022; Zhang *et al.*, 2022). Moreover, the nematode ecological indices based on nematode feeding guilds and the colonizer-persister score based on nematode life history strategies devised by Ferris *et al.* (2001) are valuable tools for assessing soil ecosystem function and health.

Soil management practices significantly impact the structure, function, and characteristics of the soil microbial community. Cover crops are a popular choice among various strategies and approaches to soil management due to their ability to enhance soil quality and productivity in agroecosystems. Leslie *et al.* (2017) observed that adding cover crops contributes energy and nutrients to the soil fauna. The increased habitat complexity resulting from cover crop residue provides a suitable environment for higher trophic groups. Cover crops can include a variety of plants, such as grasses, legumes, and non-legumes, and are often chosen based on their ability to fix nitrogen, increase organic matter, and improve soil structure (Blesh, 2018; Kocira *et al.*, 2020). Kauer *et al.* (2021) found that cover crops improve soil organic matter (SOM) and organic C levels, which benefit the belowground organisms. *Arachis pintoi (*Krapov. and W.C. Greg), also known as Pinto peanut, a warm-season leguminous plant commonly found in the Philippines, plays a significant role in soil enhancement (Saleem *et al.*, 2020). Perennial legume cover crops like *A. pintoi,* with their increased root growth, contribute to improved soil organic carbon content, enhanced nutrient availability, and better soil aggregation. Additionally, *A. pintoi* exhibits faster decomposition rates and releases nutrients more significantly. In contrast, non-legume cover crops, such as *Sphagneticola trilobata* (L. Pruski), also known as Wild Daisy, prove effective in scavenging excess nitrogen. Wild Daisy, a soil creeper forming a dense carpet, excels in soil retention and erosion control, making it a valuable tool in mitigating soil erosion on slopes and river banks in Brazil (Sousa *et al.* 2018). Setyowati *et al.* (2014) propose using *S. trilobata* as a substitute for N, P, and K fertilizer applications. Moreover, Xiang *et al.* (2023) discovered that the root exudates of *S. trilobata* also exhibit the capability to suppress soil-borne pathogenic fungi.

Cover crops incorporated into the soil enrich the food web as additional organic matter and can be observed based on the nematode community (Gruver *et al.*, 2010; Ferris *et al.*, 2012). Soil nematode communities provide a unique opportunity to assess the soil food web conditions. Several studies have explored the impact of cover crop management on the nematode community structure. However, each study has gathered different effects depending on several factors, such as the cover crop utilized, management practice, and soil condition, among other factors. A comprehensive evaluation of *Arachis pintoi* and *Sphagneticola trilobata* as cover crops requires reliable and sensitive indicators to understand their impact on soil food web conditions. This study aims to evaluate the nematode abundance and community assemblage in the cover crop planted area of Naawan, Misamis Oriental, Philippines. Particularly, this study aims to (1) determine the abundance and diversity of nematodes after cover crop incorporation and (2) assess the nematode community structure in response to the application of cover crops.

Materials and methods

Study area

A field experiment was conducted in Naawan, Misamis Oriental, located between 8°.26'02.2" N and 124°.18'02.7" E Naawan, Misamis Oriental (Fig. 1). The experiment was set up on a 1369 m^2 plot of land following a Randomized Complete Block Design (RCBD) consisting of four treatment plots, each replicated four times with a total of 16 experimental plots. Specifically, Treatment I involved planting *Arachis pintoi*, while Treatment II was *Sphagneticola trilobata*. Lastly, Treatment III encompassed mixed plots where both cover crop species were combined, and control plots were allocated where local weeds were undisturbed. Each plot measures 8 x 8 meters and has raised beds 1 foot high. The plots are kept one meter from each other. Minimal tillage was performed to form the experimental plots' desired size and eliminate weeds. The stem cuttings of the cover crops were planted and grown for a month in a small seedling bag to acclimatize and then transferred to the experimental plots.

Soil sampling and nematode extraction

The first soil samples were collected on February 25, 2023, and the second sampling was on May 25, 2023. Each plot collected at least 100 g of soil samples from 10 equidistant spots to create a composite soil sample at 0-30 cm depth (Motsara and Roy, 2015). Following the method of Martinez *et al.* (2018), in quantifying the number of nematodes in this study, 100 g of soil was extracted from a 0 to 15 cm soil layer in each treatment plot since this is where nematodes are most abundant. Homogenized soil samples were gently stored in an ice box to prevent nematodes from dying while they were transported to the laboratory and immediately processed. Using the modified tray method of Whitehead and Hemming (1965), samples were placed on a supporting wire mesh with a laid tissue paper that had water underneath for three days. Under the stereomicroscope, the first 100 alive and active nematode individuals were indiscriminately collected.

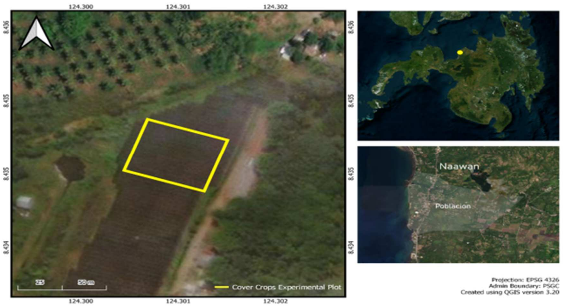

Fig. 1. Satellite map of the cover crop field experiment in Naawan, Misamis Oriental, Philippines

Nematode community analysis

Nematode assemblages were characterized by total nematode abundance and genus richness based on the genera of the 100 nematode individuals identified using the identification key guide of Bongers and Bongers (1998) and Andrássy (2005). Each nematode was assigned a 'colonizer-persister' score ranging from 1 to 5, with 1 representing extreme colonizer behavior and 5 representing extreme persister behavior according to Bongers (1990; 1999) and a trophic group based on a genus list by Yeates *et al.* (1993).

One of the two diversity indices utilized in this study is the Shannon diversity index (H'), which is a diversity measure encompassing both aspects of richness and evenness, which is [$H' = \sum Pi\ (\ln Pi)$] (Shannon, 1948). The Simpson index, developed by Simpson (1949), is the probability that two randomly chosen individuals of an infinite community belong to the same class, thus inversely related to diversity. The Simpson index (λ) is calculated as calculated as [$1- D = 1- \sum Pi^2$], is a measure of evenness; in both indices, *Pi* is the proportion of individuals of the i^{th} taxon. On the other hand, all nematode-based indices, such as the Channel Index, Enrichment Index, and Structure Index, were computed using the Nematode INdicator Joint Analysis (NINJA) online program (Sieriebriennikov *et al.*, 2014).

Statistical analysis

Descriptive statistics was utilized to calculate nematode data. Two-way analysis of Variance (ANOVA) was used to find out if there were any significant changes in nematode-based indices between treatment plots. When overall changes were substantial, pairwise comparisons were done to find differences. Before this, all nematode data were log-transformed to meet assumptions of normality. All statistical analyses were done using PAST software version 4.03.

Results and discussion

Abundance of soil nematode communities

Cover crops supported a higher nematode abundance than in the no-cover crop system. This is likely because the cover crops supply more food resources for the nematode. The cover crop integration in this study showed a significant increase in nematode abundance from 1,427 nematode individuals to 1,451 individuals observed on day 0 and day 90, respectively, across all 16 plots. The average abundances of soil nematode (Table 1) were significantly different ($p < 0.01$) in the *A. pintoi* plot, which was 247 ind/ 100 g and 333.25 ind/ 100 g on day 0 and day 90, respectively. Li *et al.* (2018) observed that cover crops support a higher nematode abundance of 41.48% to 64.61% than areas without cover crops. Higher nematode abundance is observed in cover crop areas because cover crops provide additional food resources for nematodes.

Different cover crop treatments have different effects on the nematode trophic groups. Cover crop treatments supported a higher abundance of low trophic groups of free-living nematodes. The soil nematode trophic group in day 0 was composed of 59 genera comprising 15 bacterivores, 7 fungivores, 25 omnivore-predators, and 12 herbivores were found (Fig. 2). Similarly, after 90 days, 68 genera were identified, including 24 bacterivores, 8 fungivores, 21 omnivore-predators, and 14 herbivores, highlighting a more diverse nematode community. The result is consistent with the previous research by Leslie *et al.* (2017), which found that cover crop treatments changed the structure of the nematode community and enhanced the complexity of the nematode community network. Zhang *et al.* (2022) infer that cover crops support a more complex nematode food web, as evidenced by higher fungivore, bacterivore, predator, and prey rates. Further, the mixed plot displayed the most significant increase in genera after 90 days, with an increment of 7 genera observed. Garba *et al.* (2024) state that higher plant diversity increases free-living nematode diversity. This is similar to the study of Finney and Kaye (2017), where mixing different cover crops will increase biodiversity more than monoculture cover crops.

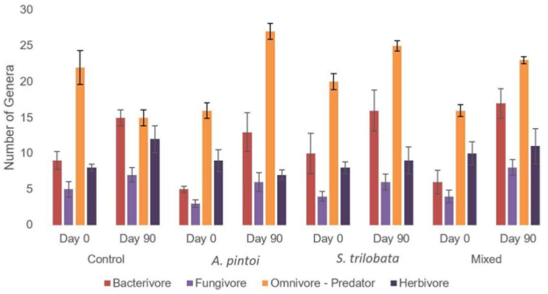

Fig. 2. Number of genera per trophic group across all treatments.

Among the nematode group, only fungivore was significantly affected by *S. trilobata,* and the herbivore trophic group was significantly affected by *A. pintoi*, respectively. Several reports observed herbivore groups dominate in most agricultural systems exposed to different tillage practices Zhang *et al.* (2019), organic vegetable fields (Martínez-García *et al.*, 2018), and different plantations (Aguirre *et al.*, 2016). Percent composition of the herbivore trophic group (Table 2) revealed the most abundant among all trophic groups in all plots on day 0, prominently in mixed plots (62.34%), followed by *A. pintoi* (61.35%), *S. trilobata* (49.32%), and lowest in control (38.98%). The 90-day cultivation of the cover crops did not significantly reduce the herbivore composition. However, 26.2% of the herbivores were decreased only in monoculture *A. pintoi* cover crops recorded, whereas *S. trilobata* had a higher herbivore composition of 39.77%. It is crucial to assess the plant-feeder composition in cover crop cultivation as the use of cover crops can also carry the risk of increasing the abundance of plant-parasitic nematodes that could undermine system productivity.

The result of this study highlights how cover crops influence soil nematode populations, particularly the plant-feeder nematode genus *Hoplolaimus*. Accordingly, the plant-feeder *Hoplolaimus* dominates the most in both sampling times, composing 22.11% of the overall nematode percent composition before cover crop addition and declining by 13.44% after 90 days of planting the cover crop. The *A. pintoi* cover crop declined *Hoplolaimus* abundance after 90 days, indicating that these crops may have a suppressive effect on plant-feeding nematodes. The decline was from 29 ind/100g to 10.75 ind/100g in the *A. pintoi* plot and from 13 ind/100g to 5.50 ind/100g in the mixed plot, compared to the control plot's 24.25 ind/100g to 21.75 ind/100g (Table 2). This finding aligns with research by Grabau *et al.* (2017) and Leal-Bertioli *et al.* (2016), demonstrating a reduction in plant-feeder nematode populations by introducing cover crops.

The research also found that cover crops may affect different nematode taxa differently. The increase in dominant genera, *Filenchus*, *Aphelenchus*, and *Belondira* populations, suggests this. In the control plot, *Filenchus* populations increased from 8 ind/100g to 13.50 ind/100g, while in the *A. pintoi* plot, they increased from 11 ind/100g to 12 ind/100g. Meanwhile, the significant changes in the *Aphelenchus* ($p < 0.001$) population in the mixed plot increased from 2 ind/100g to 12 ind/100g. Zhang *et al.* (2023) highlighted the potential role of *Apelenchus avenae,* one of the two species under the taxa, which is found to alleviate damping-off disease incidence caused by *Pythium ultimum* in tomatoes. The result suggests that changes in nematode abundance and composition induced by cover crops may have broader implications for soil-borne disease dynamics and plant health. Furthermore, the significant growth in *Belondira* ($p < 0.01$) populations before and after cover crop addition underscores the complexity of soil nematode responses to cover crop management. The study found significant growth in Belondira populations both before and after cover crop addition.

Based on the feeding habits and life history traits of nematodes summarized in Table 2, the colonizer-persister scores are utilized in assessing ecosystem condition and function. Accordingly, "colonizers" (cp 1 and 2) are nematodes that are highly tolerant to pollution, while "persisters" (cp 3-5) are nematodes that are highly sensitive to soil disturbances (Bongers and Bongers, 1998). Most of the nematodes in the day 0 soil samples are bacterivore opportunistic nematodes with a cp2 value, except in the *A. pintoi* plot, where persister nematodes are the most abundant. After cover crop integration, cp2 fungivore nematodes are higher. Based on the study of Van Den Hoogen *et al.* (2019), acidic soils can substantially reduce microbial activity, causing a shift from bacterial to fungal-driven pathways. After planting cover crops, the soil in the experimental plots significantly becomes moderately acidic (5.53 pH - 5.65 pH). Hence, the dominance of fungivore nematodes could be due to the acidic soil in the area. In addition, the capability of legume cover crops to suppress pathogens also causes an increase in soil fungal diversity by adding other plant residues (Esmaeilzadeh-Salestani *et al.*, 2021). Although, Du Preez *et al.* (2022) pointed out that an increase of persister nematodes may take many years. There is an exclusive increase of persister nematodes (cp 4 and 5) within the *A. pintoi* plot. These persister nematodes comprise large carnivores, small omnivores, and some bacterial feeders sensitive to soil disturbances and thrive in healthy soil conditions. The presence of persister nematodes implies a lower risk of pest outbreaks, as they are essential in regulating pest populations (Wang and Hooks, 2011). The study by Sánchez-Moreno and Ferris (2018) emphasizes that the presence of omnivorous and predatory nematodes, such as those observed in the *A. pintoi* plot, signifies the intactness of the soil food web structure, and suggests a higher potential for resilience within the soil community.

Table 1. Mean values of nematode individual, trophic group abundance, and functional indices

Index name	Control	*A. pintoi*	*S. trilobata*	Mixed
Day 0				
Absolute abundance	190.75	247.5**	161.5	133
Richness	29	21	26	22
H’[a]	3.32	3.00	3.11	2.94
λ’ [a]	0.64	0.47	0.57	0.67
EI[b]	52.59	48.31	38.53	44.39
SI [b]	88.89	84.59***	88.95***	84.17
CI [b]	55.26	73.33	84.12	64.78
Day 90				
Absolute abundance	283.5	333.25**	247	233.75
Richness	31	24	26	29
H’[a]	3.28	3.07	3.09	3.27
λ’ [a]	0.66	0.67	0.64	0.72
EI[b]	51.07	51.07	41.75	47.15
SI [b]	73.34	78.57***	75.33***	72.33
CI [b]	68.62	69	84.76	76.48

[a]Number of genera (Richness), Shannon Diversity Index (H’), Simpson’s Index (λ’); [b]Calculated nematode-based indices; Enrichment Index (EI), Structure Index (SI), Channel Index (CI). *Significantly different based on pairwise comparison, *$p< 0.05$, **$p <0.01$, $^{***}p < 0001$

Table 2. Mean absolute abundances of nematode genera, trophic, and cp groups of nematodes after 90 days of planting cover crops. Values represent mean and standard deviation (mean ± sd)

Genus	Family	CP/PP	Control	*A. pintoi*	*S. trilobata*	Mixed
Bacterivore						
Acrobeles	Cephalobidae	2				0.50 ± 0.50
Acrobeloides	Cephalobidae	2	0.50 ± 0.50	0.75 ± 1.30	0.50 ± 0.50	0.50 ± 0.87
Alaimus	Alaimidae	4	0.50 ± 0.50	1.50 ± 1.66	1 ± 1.73	0.50 ± 0.50
Amphidelus	Amphidelidae	4	0.50 ± 0. 87	0.00 ± 0.00	0.25 ± 0.43	0.25 ± 0.43
Cephalobus	Cephalobidae	2	2.25 ± 0.83	2.50 ± 2.87	3 ± 2.12	4 ± 0.71
Cervidellus	Cephalobidae	2		1 ± 1.22		
Curviditis	Rhabditidae	1				0.25 ± 0.43
Eucephalobus	Cephalobidae	2	2.75 ± 1.79	4.75 ± 2.49	2.25 ± 1.30	2.75 ± 2.68
Eumonhystera	Monhysteridae	2		0.50 ± 0.87	1.50 ± 2.06	0.75 ± 0.83
Geomonhystera	Monhysteridae	2	0.25 ± 0.43			
Heterocephalobus	Cephalobidae	2	1.50 ± 1.12	1.50 ± 1.12	2.50 ± 1.66	2.25 ± 1.30
Mesorhabditis	Rhabditidae	1	1.75 ± 1.92	2.50 ± 2.50	0.75 ± 0.83	1.75 ± 2.49
Monhystera	Monhysteridae	2			0.50 ± 0.87	
Odontolaimus	Odontolaimidae	3	4.50 ± 3.28	3 ± 4.64	2.25 ± 2.28	2.25 ± 2.28
Panagrolaimus	Panagrolaimidae	1	0.50 ± 0.50	0.50 ± 0.87		0.25 ± 0.43
Paramphidelus	Amphidelidae	4	1.25 ± 0.43		1.25 ± 1.30	0.43
Pelodera	Rhabditidae	1	0.25 ± 0.43			0.50 ± 0.87
Plectus	Plectidae	2	2.00 ± 1.58	1 ± 1.22	1.75 ± 1.09	2.75 ± 1.92
Prismatolaimus	Prismatolaimidae	3	1.00 ± 0.00	1.50 ± 1.50	1.75 ± 1.48	0.75 ± 0.83
Punctodora	Chromadorida	3	0.25 ± 0.43			
Rhabditis	Rhabditidae	1		0.75 ± 1.30		0.25 ± 0.43
Rhabditoides	Rhabditidae	1			0.25 ± 0.43	
Rhabdolaimus	Rhabdolaimidae	3			0.25 ± 0.43	
Udonchus	Rhabdolaimidae	3			0.25 ± 0.43	
Fungivore						
Aphelenchoides	Aphelenchoididae	2	1.50 ± 1.50	1.25 ± 1.64	2 ± 2	1.75 ± 2.05
Aphelenchus	Aphelenchidae	2	7.25 ± 1.92	7.25 ± 3.56	6 ± 2.35	12 ± 4.30
Diphtherophora	Diphtherophoridae	3				0.25 ± 0.43
Enchodelus	Qudsianematidae	4	0.25 ± 0.43			0.50 ± 0.50
Epidorylaimus	Tripylidae	3	2.50 ± 1.80	2.25 ± 2.28	1.25 ± 1.09	4.50 ± 1.50
Filenchus	Tylenchidae	2	13.50 ± 8.96	12 ± 5.15	6.75 ± 2.17	8.25 ± 3.56
Leptonchus	Nordiidae	4	0.50 ± 0.50	2.25 ± 1.48	1.50 ± 2.60	1.50 ± 2.60
Paraphelenchus	Aphelenchidae	2	1 ± 1.73	0.75 ± 0.83	1 ± 0.71	1.50 ± 1.50
Omnivore						
Aporcelaimus	Aporcelaimidae	5	0.50 ± 0.50	0.25 ± 0.43	0.75 ± 1.30	0.50 ± 0.87
Crassolabium	Dorylaimidae	4		0.50 ± 1.66	0.50 ± 0.50	
Dorylaimus	Dorylaimidae	4	0.25 ± 0.43			

Drepanodorylaimus	Dorylaimidae	4	0.75 ± 0.83	1.25 ± 1.09	0.25 ± 0.43	
Laimydorus	Dorylaimidae	4		0.50 ± 0.87		
Mesodorylaimus	Dorylaimidae	4		0.25 ± 0.43		
Prodorylaimus	Dorylaimidae	4	0.25 ± 0.43		0.25 ± 0.43	0.50 ± 0.87
Pungentus	Nordiidae	4	1 ± 0.71	1.00 ± 1.22	0.75 ± 0.83	0.75 ± 0.43
Predator						
Achromadora	Criconematidae	3	1.25 ± 0.83	2.25 ± 1.64	2.50 ± 3.28	3.50 ± 2.18
Actus	Tylenchidae	2	0.50 ± 0.87	0.75 ± 0.83	0.25 ± 0.43	1.25 ± 0.83
Discolaimus	Qudsianematidae	4	1.75 ± 1.30		3.25 ± 1.92	1.75 ± 1.79
Eudorylaimus	Qudsianematidae	4	4 ± 1	3.00 ± 2.12	2.25 ± 1.92	3.25 ± 1.09
Iotonchus	Anatonchidae	4	0.50 ± 0.50		0.25 ± 0.43	
Ironus	Ironidae	4	0.50 ± 0.50	0.50 ± 0.50		0.25 ± 0.43
Mononchulus	Mononchulidae	4		1 ± 1.73		
Mononchus	Mononchidae	4			0.25 ± 0.43	
Mylonchulus	Mylonchulidae	4	0.50 ± 0.50	0.50 ± 0.50	0.25 ± 1.43	0.25 ± 0.43
Nygolaimus	Nygolaimidae	5	1 ± 0.71	1.25 ± 0.43	0.75 ± 1.30	0.75 ± 0.83
Thalassogenus	*Thalassogeneridae*	5	0.25 ± 0.43			
Tripyla	Tripylidae	3		0.25 ± 0.43		0.25 ± 0.43
Tripylina	Trischistomatidae	3	1 ± 0.71	1.00 ± 1.00	0.75 ± 0.83	2 ± 0.71
Trischistoma	Trischistomatidae	3	1.25 ± 0.83	0.25 ± 0.43	0.25 ± 0.43	0.75 ± 0.83
Herbivore						
Aglenchus	Tylenchidae	2	0.75 ± 0.83	0.50 ± 0.87	0.25 ± 0.43	0.50 ± 0.50
Belondira	Cephalobidae	5	2.50 ± 1.50	5 ± 3.54	3.75 ± 2.49	5.50 ± 2.60
Coslenchus	Tylenchidae	2	1.75 ± 2.05	0.50 ± 0.50	1 ± 0.71	3.25 ± 3.34
Criconema	Criconematidae	3	1 ± 1.73		1.50 ± 1.66	0.25 ± 0.43
Discotylenchus	Tylenchidae	2				0.50 ± 0.87
Dorylaimellus	Dorylaimidae	5	2 ± 0.71	2 ± 1.58	0.75 ± 0.83	3.25 ± 0.83
Gracilacus	Paratylenchidae	2	0.25 ± 0.43			
Helicotylenchus	Hoplolaimidae	3	0.50 ± 0.50	0.25 ± 0.43	1 ± 1	1.75 ± 1.92
Hirschmaniella	Pratylenchidae	3	0.25 ± 0.43			
Hoplolaimus	Hoplolaimidae	3	10.75 ± 3.03	10.75 ± 6.18	21.75 ± 22.93	5.50 ± 3.64
Pratylenchus	Pratylenchidae	3	0.50 ± 0.87			0.50 ± 0.50
Rotylenchulus	Rotylenchulidae	3	6.00 ± 3.74	1.75 ± 1.48	3.50 ± 2.29	7.25 ± 4.71
Rotylenchus	Hoplolaimidae	3	1.75 ± 1.79	0.00	0.75 ± 0.83	1.50 ± 2.60
Tylenchus	Tylenchidae	2	1.50 ± 1.50	1.25 ± 1.64	0.25 ± 0.43	2.75 ± 2.17
Tropic groups						
Bacteriovores			16.55	21.22	21.02	19.25
Fungivores			26.09	28.1	19.92	25.25
Omnivores-Predators			9.90	18.20	15.04	15.75
Herbivore			32.06	26.2	39.77	32.5
c-p value %						
cp1			2.75	4.41	1.15	3.00
cp2			40.38	41.76	33.72	44.00
cp3			32.97	24.71	42.65	26.50
cp4			17.31	19.12	15.56	16.50
cp5			6.59	12.65	6.92	10.00

Diversity indices

The diversity indices, namely the Shannon-Wiener diversity index and Pielou's evenness, measure diversity based on species abundance and provide insight into the balance of species abundance within a community. The Shannon-Wiener diversity index considers species richness and evenness (Shannon, 1948). Meanwhile, Pielou's evenness measure focuses on the even distribution of individuals among species. Based on mean diversity index value (Table 1), both diversity indices showed no significant differences in nematode evenness and diversity. The control group initially had the highest diversity and evenness. However, over time, there was a slight decrease in diversity and evenness within the control group, possibly due to factors such as competitive exclusion or environmental changes. The diversity of *A. pintoi* and *S. trilobata* appeared similar, with the latter showing a declining trend in all cover crop plots based on the Shannon-Weaver index. Meanwhile, the evenness increased for *A. pintoi* and decreased slightly for *S. trilobata*. Interestingly, the mixed treatment showed increased diversity and evenness after cover crop integration. Increasing cover crop diversity also promotes a more diverse and balanced distribution of individuals within the community (Gomez *et al.*, 2018).

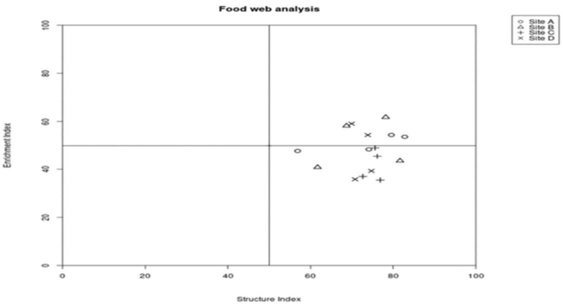

Fig. 3. Nematode weighted faunal analysis profile after cover crop integration (Ferris *et al.*, 2001)

Nematode-based indices

Nematode-based indices are widely used for assessing the ecological properties, functional roles, and community dynamics of nematode assemblages within soil ecosystems. The Enrichment (EI), Structure (SI), and Channel (CI) indices are calculated from the weighted faunal components (Ferris *et al.*, 2001). EI depicts whether the soil food web is enriched with nutrients, whereas SI illustrates if the soil communities are stable and undisturbed. The CI indicates whether the soil food web is diminished by stress or limited in nutrient resources. After 90 days, the enrichment index remained relatively stable in the control group and *A. pintoi* treatment. Meanwhile, EI decreased in the mixed treatment and slightly improved in the *S. trilobata* treatment (Table 1). The differing responses of the enrichment index among treatments highlight the importance of cover crop selection in influencing soil nematode communities. A higher EI values indicate resource enrichment and can be used to classify more undisturbed and more stable habitats (Ferris *et al.*, 2001). For instance, the plot of *A. pintoi* maintained a stable high enrichment index, suggesting its potential to support diverse trophic groups and contribute to soil ecosystem stability. The changes in the enrichment index for *S. trilobata* and the mixed treatment after 90 days may suggest a shift in soil resource availability. This could be due to changes in nutrient availability, soil organic matter decomposition rates, or alterations in plant-microbe interactions induced by the cover crops. Agricultural systems often have low SI values compared to natural areas, and if SI increases, it is gradual (Ferris *et al.*, 2001; DuPont *et al.*, 2009). Similarly, this study recorded reduced SI values in all plots after cover crop incorporation. The structure index decreased significantly ($p < 0.001$) in *S. trilobata* plots after 90 days (Table 1), which was influenced by a decline in higher trophic groups such as omnivores and predators.

The channel index (CI) reflects the structural changes in the decomposition pathway in the soil food web. A higher value (CI > 50) indicates a fungal-dominated pathway, and a lower (CI < 50) reflects a bacteria-dominated pathway (Ferris *et al.*, 2001; Kou *et al.*, 2020). Channel index has become relatively higher after incorporating cover crops, although not significantly in all plots. This result can be explained as cover crop treatments also increase organic matter. Particularly, the CI tended to be greater in *S. trilobata* than in other plots, suggesting higher fungal dominance in the soil food web than in other cover crop plots. According to other studies, a fungal-dominated decomposition occurs in less disturbed, late successional sites, often with acidic soils that are of high organic matter content and low resource quality (Wardle *et al.*, 2004; Yao *et al.*, 2022). The faunal profile developed by Ferris *et al.* (2001) revealed that most experimental plots are characterized as an environment with an undisturbed and structured food web, moderately enriched with moderate to high C: N ratio and fungal decomposition channels (Fig. 3). Meanwhile, the remaining plots are in Quadrant B which represents an environment with a low to moderate degree of disturbance and a maturing food web, N-enriched with low C: N ratio and with balanced decomposition (Ferris *et al.*, 2001). Using soil nematodes as indicator taxa, result shows that cover crops can maintain soil food web complexity and promote nutrients enrichment.

Conclusion

The findings of this study showed that the short-term evaluation of the effect of cover crops on the nematode community has increased nematode abundance and diversity. Mainly, *Arachis pintoi* enhances the nematode community composition by increasing the number of sensitive nematode genera and reducing the number of herbivorous nematodes. In addition, cover crops had minimal impacts on the nematode community, suggesting that the observation period may have detected minimal impacts on the soil food web.

Recommendation(s)

This study recommends implementing long-term field studies to understand cover crop benefits in agriculture. DNA-based methods are also suggested for more accurate nematode identification.

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