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Preface

In the name of ALLAH, Most Gracious, Most Merciful and Muhammad S.A.W., the last prophet.

First and foremost I would like to congratulate the editorial board and authors of the *Borneo Akademika* journal on their success in producing this journal. This achievement is actually the result of their tireless effort in contributing thoughts and ideas to produce papers on current issues and challenges in multi-disciplinary research. To the best of my knowledge, efforts to produce a home-grown UiTM Sabah journal actually started ten years ago, and today we see the fruits of our labour and patience. This shows us that total commitment from the academic community is required in the journey towards academic publication so that joint research efforts can be enhanced.

This journal consists of twelve peer-reviewed articles based on current research topics of interest. Each topic is unique by way of its research methodology and findings in various related fields. The papers in this journal are useful to fellow researchers who share a similar interest in the field or those who are directly involved in exploring multi-disciplinary research. We hope that this publication can be a reference for academicians and students alike, particularly those in UiTM as well as the general public.

Finally, I would like to take this opportunity to acknowledge the dedication of our editorial board and invited/field editors who have in one way or another contributed to the successful publication of this journal. My gratitude goes out to all the authors who contributed articles to this publication because this journal would not have become a reality without them.

Thank you.

Datuk Dr. Hj. Abdul Kadir Hj. Rosline
Chief Editor

Prakata

Dengan Nama Allah Yang Maha Pemurah Lagi Maha Mengasihani. Salam dan Selawat ke atas Junjungan Besar Nabi Muhammad SAW rasul akhir zaman.

Pertamanya saya ingin mengucapkan setinggi-tinggi tahniah kepada sidang penyunting dan penulis artikel jurnal Borneo Akademika yang menyumbang tenaga dan idea dalam isu dan cabaran terkini kajian pelbagai-bidang. Penerbitan jurnal ini adalah keseinambungan usaha lampau yang kurang aktif semenjak hampir sepuluh tahun lalu. Jurnal ini menggambarkan keperluan komitmen yang jitu daripada warga akademia bagi megembang kesignifikanan usaha-usaha dalam penyelidikan.

Jurnal ini mengandungi dua belas artikel yang dinilai oleh penilai jemputan/bidang berasaskan kajian semasa. Setiap tajuk yang dibincang mempunyai keunikan tersendiri yang metodologi dan dapatannya dikupas berdasarkan bidang kajian yang dibuat. Usaha ini amat memberi manfaat kepada penyelidik-penyelidik terutamanya mereka yang terlibat secara langsung dalam kajian terkini pelbagai-bidang. Tambahan pula, kami berharap agar penerbitan ini akan menjadi sumber rujukan kepada ahli akademik dan pelajar terutamanya di UiTM dan juga kepada orang awam lain.

Akhirnya, kami ingin mengambil kesempatan untuk merakamkan setinggi-tinggi penghargaan kepada semua ahli sidang penyunting dan penyunting jemputan atas sumbangan yang merupakan satu lagi cara menyumbang kepada kejayaan penerbitan jurnal ini. Terima kasih khas ditujukan kepada semua penulis yang menyumbang artikel untuk tujuan penerbitan ini kerana tanpa sumbangan mereka penerbitan ini tidak mungkin dapat dijayakan.

Terima kasih.

Datuk Dr. Hj. Abdul Kadir Hj Rosline
Ketua Penyunting

Content

THE ABUNDANCE OF NEMATODE IN CABBAGES GROWN IN CONVENTIONAL AND ORGANIC FARMING SYSTEMS

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ABSTRACT

A study on the abundance of nematodes in cabbages grown in two different farming systems was carried out in Kundasang, Sabah. The aim was to compare the population of nematodes in organic and conventional farming systems. Soil samples were collected in September 2013 during the cabbage growing season. Nematodes were extracted from soil using Baermann funnel method. The results revealed that conventional farming favoured the population of plant feeder nematodes, whereas the organic farm had significantly higher population of total free living nematodes during the period of the study. However, the negative correlation in population of plant feeder and free living nematodes indicated that there was no competition between the two nematode populations in the soil.

Keywords: Plant feeder nematode; conventional farming; organic farming

ABSTRAK

Satu kajian kepadatan nematod pada dua sistem perkebunan kubis telah dijalankan di Kundasang, Sabah. Tujuan utama adalah untuk membezakan populasi nematod di kebun yang dikendalikan secara konvensional dan organik. Nematod dipencilkan daripada tanah dengan kaedah *Baermann funnel*. Didapati populasi nematod pemakan tumbuhan adalah lebih tinggi di kebun konvensional manakala kebun organik menunjukkan populasi nematod bebas adalah lebih tinggi pada masa kajian dijalankan. Walaubagaimanapun, korelasi negatif di antara populasi nematod pemakan tumbuhan dan nematod bebas menunjukkan bahawa tidak ada persaingan di antara ke dua-dua populasi nematod ini di dalam tanah.

Kata kunci: Nematod pemakan tumbuhan; kebun konvensional; kebun organik

1.0 Introduction

The leading crop grown in the district of Kundasang is cabbage (*Brassica oleracea* L. var *capita*) and the two main farming systems practised for vegetable cultivation are the conventional and organic farming systems (Ministry of Agriculture, 2007). The conventional farming system uses synthetic chemical fertilisers to supply nutrients to the crops while organic management places an emphasis on organic wastes to supply nutrients on the matching plant demand (Neher, 1999).

Soil nematodes play an important role in plant nutrient cycling and plant growth (Moore & De Ruiter, 1991), and could keep stabilisation of soil ecosystem and energy flowing (Ingham, Tofymow, Ingham & Coleman, 1985). Soil nematode communities are very sensitive to any changes in the food supply and soil environment (Neher, 1999). Nematodes are usually classified into plant feeder nematodes and free living nematodes depending on whether the

nematode is harmful or beneficial to the plant (Lee, 2002). They can be differentiated based on their mouthparts, in which plant feeder nematodes are equipped with a stylet that is used to puncture plant tissues.

Plant feeder nematode feeds on plants and reduces crop growth and productivity (Pokharel & Larsen, 2007). This has led to the loss in crop quality and quantity. However, information with regard to nematode population in this context is not up to date. This is due to the fact that studies on the impact of nematodes on their specific host crops and habitat are limited and are not carried out repeatedly for most of the crops (Bird & Bird, 2001; Dong & Zhang, 2006). Therefore, there is a significant need to study different farming management practices affecting nematode community to inform nematode disease management strategies.

2.0 Materials and Methods

The soil nematodes were extracted with Baerman funnel method.

2.1 *Sample collection*

One core of 2 cm diameter and 20 cm depth samples were collected from 30 points of equally spaced sites of each farm. A composite sample was made to represent each organic and conventional farming system. Bulking soil samples through this method helps to preserve them by maintaining the moisture and temperature of soil samples (International Institute of Tropical Agriculture, 2007).

2.2 *Sampling pattern*

Nematodes are rarely distributed evenly in a field. Random sampling pattern was not chosen because it does not accommodate the patchy nature of nematode distribution.Therefore, a systematic sampling with zigzag pattern was applied in this study because it is a more structured way to take soil samples as the nature of the field and nematode distribution are considered (Ou, Liang, Liang, Li, & Wen, 2005; Shabdin & Othman, 2008; Tabarant et al., 2011).

2.3 *Time of sampling*

Nematode population was at its peak during the growing season and reduces during the off season (Briar et al., 2011; Liang et al., 2009; Ugarte, Zaborski, & Wander, 2013). For that reason, soil samples were collected late in the growing season as the number of nematodes are likely to be highest within that period of time.

2.4 *Soil sampling*

Auger was used to extract soil samples from the ground. Once the auger was full, soil sample was removed carefully and placed into a soil bag. Soil samples were taken to the depth of 20 cm directly in the root zone as the area was likely to have the most plant associated nematodes.

2.5 *Sample extraction with the Baermann Funnel Method*

Nematodes were isolated from the soil samples according to Briar et al. (2011) with some modification. Thirty grams of soil sample was folded with filter paper and placed in the funnel. Prior to that, the funnel was filled with distilled water up to half of the funnel height.

More distilled water was added until the soil in the filter paper was barely submerged. Observation was done after 48 hours with Olympus EX51 high magnification microscop

2.6 *Classification of the nematodes*

Each of the nematodes was classified into plant feeder and free-living nematodes based on the structure of their mouthparts and the presence of a stylet according to Bell et al. (2009).

2.7 *Data analysis*

Data were analyzed using the IBM SPSS Statistics 21 software. Normality test was done using Shapiro-Wilk test and non-parametric test using Mann-Whitney test to compare the population between plant feeder and free living nematodes in the two different farming systems (Dytham, 2003). Spearman rank correlation was carried out to assess the correlation of both nematode populations.

3.0 Results and Discussion

3.1 *Nematode counting*

A total of 149 nematodes were extracted from both farming systems, in which 35% were plant feeder nematodes and 65% were free living nematodes respectively. Figure 1, Figure 2 and Figure 3 present some of the nematode images observed under Olympus EX51 High Magnification Microscope.

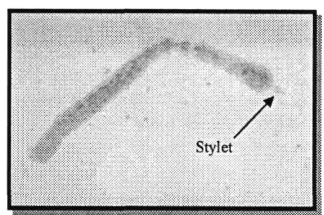

Figure 1: Plant feeder nematode at 40x magnification.

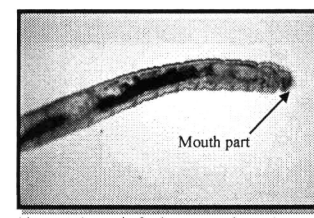

Figure 2: Bacteria feeder nematode at 40x magnification.

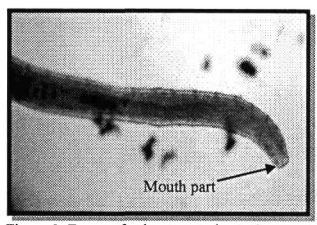

Figure 3: Fungus feeder nematode at 40x magnification.

3.2 *Comparison between plant feeder and free living nematode population*

Plant feeder nematodes were more abundant in conventional farming system as indicated by the higher mean at 52.48 compared to 32.52 in organic farming system (Figure 4, Table 1). This finding is similar to that of Neher (1999) and Briar, Grewal, Somasekhar, Stinner, & Miller (2007) in which they found that plant feeder nematodes population was higher in conventional farming system. Ferris & Bongers (2006) also discovered that the total biomass indicators of activity in the nematode channels were greater in the conventional soil. In contrast, organic farming system showed lesser plant feeder nematode population compared to conventional farming system. This finding is similar to that of Nahar et al. (2005).

As plant feeder nematodes feed on the roots of the plant (Ugarte *et al.*, 2013), it will not be attracted to consume the chemical fertilisers. Hence, they cannot be controlled with chemical fertilisers, which answered its high abundance in conventional soil that use synthetic chemical fertilisers (Ghorbani, Wilcockson, Koocheki, & Leifert, 2008). Organic farming system favours free living nematodes as compared to plant feeder nematodes with higher mean reading at 51.57 compared to 33.43 in conventional farming system (Figure 4, Table 2). This finding was also observed in a previous study by Briar et al. (2007).

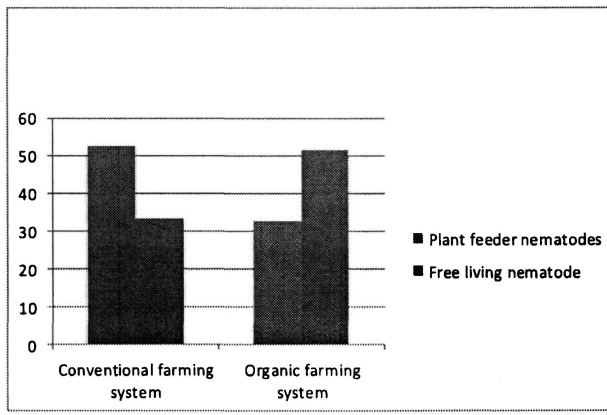

Figure 4: Comparison between plant feeder and free living nematodes population in conventional and organic farming systems in Kundasang, Ranau.

Table 1: Mann-Whitney Test for plant feeder nematode population in conventional (1) and organic farming systems (2) in Kundasang, Ranau.

Ranks				
	TOS	N	Mean Rank	Sum of Ranks
PF	1	42	52.48	2204.00
	2	42	32.52	1366.00
	Total	84		

Table 2: Mann-Whitney Test for free living nematode population in conventional (1) and organic farming systems (2) in Kundasang, Ranau.

Ranks				
	TOS	N	Mean Rank	Sum of Ranks
FL	1	42	33.43	1548.00
	2	42	51.57	2022.00
	Total	84		

The free living nematodes have higher Carbon and Nitrogen ratio than their substrate (Ferris & Bonger, 2006). Soil managed organically provides both organic matter and microbes as the sources of food for soil nematodes. Plant feeder and bacterial feeder nematodes contain high C: N ratio compared to the substance in their food sources so that they will release nitrogen as a waste product (Griffiths, Daniell, Hallet, Neilson, & Wheatley, 2010). When there is abundance of bacteria in soil, bacterial feeder nematodes may dispose amino acids in substantial amounts (Qi & Hu, 2007). However, when the bacterial populations reduce, nematodes will begin to starve and start to increase ammonium excretion as they have to catabolize protein for energy maintenance (Wu, Chellem, Graham, Martin, & Rosskopf, 2008).

Nitrogen substance is said to be an important measure of potential microbial activity related to the rate of decomposition (Qi & Hu, 2007). Since the fertilisers in conventional farm are made of chemical synthetic fertilisers containing Nitrogen, bacterial communities are attracted to consume the chemical fertilisers which in turn suppressed their population by directly poisoning them (Griffiths et al., 2010). This directly affects the population of free living nematodes, especially bacteria feeder nematodes, in soil managed conventionally since it has less bacterial community. Somehow, free living nematodes especially bacteria feeder is beneficial in the agricultural soils as it helps in increasing the availability of readily-decomposable organic matter (Ugarte et al., 2013).

Organic farming system which does not use synthetic chemical and inorganic fertilisers generally result in healthy ecological properties in the soil (Griffiths et al., 2010). This is attributed to the organic matter it contains as well as the active microbial activity, better soil structure and lower bulk density (Chitwood, 2003). In addition, greater organic content leads to higher levels of soil fertility and results in greater crops productivity (Neher, 1999).The use of organic amendments with relatively low Carbon and Nitrogen ratios could act as nematicidal agents because it decreases the plant feeder nematodes and increases free-living nematodes (Briar et al., 2011).

3.3 *Correlation between plant feeder and free living nematode population*

Results from the Spearmen's rank correlation indicated that there is evidence of negative relationship between the plant feeder and free living nematode population in both farming systems (Table 3). This finding is similar to that of Georgieva, McGarth, Hooper, & Chambers (2002) and Nahar et al. (2005). The result also shows that there is no competition between plant feeder and free living nematodes population in both farming systems. This is because each type of nematodes feeds on different sources of nutrients. Plant feeder nematode feed on plant tissues while the free-living nematode mostly feed on bacteria, fungi, other nematodes and protozoa (Shannon, Sen, & Johnson, 2002; Wu, Huh, & Ingham, 2005).

Table 3:Spearman's Test for Correlation of nematode in both farming system

Correlations				
			PF	FL
Spearman's rho	PF	Correlation Coefficient	1.000	-.279*
		Sig. (2-tailed)	.	.010
		N	84	84
	FL	Correlation Coefficient	-.279*	1.000
		Sig. (2-tailed)	.010	.
		N	84	84
*. *Correlation is significant at the 0.05 level (2-tailed).*				

According to Neher (1999) and Briar et al. (2007), the types of nematode that dominate in the soil depend on the type of farming system applied. Meanwhile, Georgieva et al. (2002) reported that the abundance of nematodes population is correlated with the soil heavy metal concentrations. Other factors that affect the population of nematodes in soil are the microbes abundance which positively correlate with the bacteria feeder nematodes (Briar et al., 2011).

4.0 Conclusion

The data presented in this study shows that the conventional farming system has a higher population of plant feeder nematodes compared to the organic farming system. Additionally, there is a noticeable reduction of plant feeder nematodes in organic farming system. The negative correlation between the population of plant feeder and free living nematodes indicates that there is no competition between the plant feeder nematode and free living nematode since both types of nematodes feed on different nutrient sources.

Findings from this study suggest that the best farming strategy for cabbage is the organic farming system since the application of organic fertilisers such as vegetables wastes, as used in the study area, enhanced the number of free living nematodes. The bacteria feeder is beneficial for nutrient cycling in the soil to produce healthy soil ecosystem and at the same time reduce the number of plant feeder nematodes that are damaging the crop.

As the study was conducted in highland vegetable farming system, it is recommended that future studies be extended to lowland vegetable farming system. An active nematology study for other crop productions should also be encouraged to update current findings. Last but not least, different extraction methods such as sugar floatation and sieving method can be conducted in the future to improve the results of the current study.

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