www.bircu-journal.com/index.php/birci
Budapest International Research and Critics Institute-Journal (BIRCI-Journal)
Humanities and Social Sciences
ISSN 2615-3076 Online)
ISSN 2615-1715 (Print)
Budapest Institute

Collembola Population Dynamics in Plants Organic Soybeans for Human Life

Chichi Josephine Manalu[1], Yusmaidar Sepriani[2]
[1]*Agricultural Faculties of Methodist, University of Indonesia*
[2]*Faculty of Science and Technology, Labuhanbatu University*
chichi.manalu@yahoo.com

Abstract

The diversity of soil organisms creates a variety of functions and processes in the soil. Each community of organisms performs different functions, among others, as nitrogen fixer, phosphate solubilizer, decomposer of organic matter, producer of phytohormones and antibiotics, and can be viewed as a soil ecosystem. Soil fauna plays a very big role in improving soil fertility. Soil fauna is classified as mesofauna, one of which is Collembola. Collembola is a group of microarthropods that has a wide distribution in various types of soil in the world. The role of Collembola in the soil is to destroy organic matter into smaller sizes and then mix them. Collembola is widely used as a biological indicator and ecosystem monitoring. The results showed that: The population of Collembola in organic soybeans had a value of 183 individuals/m2, Biomass of Collembola in organic soybeans had a value of 2.56 mg/m2, Collembola diversity in organic soybeans had a value of 0.89 (classified as low), Population, biomass and diversity of Collembola have a good impact on soil fertility, so it is a positive thing for people who cultivate, especially organic soybeans. Organic soybean cultivation is a good product for people, especially those who currently prioritize health.

Keywords
soil fauna; collembola; organic soybeans

I. Introduction

Organic agriculture is understood as a crop production system based on biological nutrient recycling. Organic agriculture is a whole production management system that promotes and develops agroecosystem health, including biodiversity, soil cycles and biological activities. This agriculture emphasizes management practices that prioritize the use of off-farm inputs and take into account regional conditions of locally adapted systems (Sutanto, 2002). Organic agriculture is a whole systems approach based on a set of processes that produce sustainable ecosystems, safe food, good nutrition, animal welfare and social justice, is a philosophy that optimizes the health and productivity of interconnected communities, namely life soil organisms, plants, animals, and humans (Apriantono, 2008). One of these interconnected communities is the life of the soil fauna, one of which is Collembola. The life of soil fauna is very dependent on its habitat, because the presence and population density of a type of soil fauna is determined from environmental factors, namely the biotic environment and abiotic environment.

Agricultural land is increasingly narrow due to the shifting of the function of agricultural land into industrial areas, so that hydroponic cultivation is considered appropriate to utilize available land because this cultivation system does not require soil media. The hydroponic system uses a variety of planting media other than soil, among others, with media such as fuel husk, husk, sand, zeolite, rockwoll, peat (peat moss) and coconut husk powder (Prihmantoro in Zalilani, M. et al. 2019)

DOI: *https://doi.org/10.33258/birci.v5i1.4379*

Collembola is one of the microarthropod groups that has a distribution spread across various types of soil in the world. Collembola is also known as springtails or tails because of the presence of a body pelenting device on the tail called furkula (Coleman et al. 2004) Collembola's body size ranges from 0.25 mm to 8.0 mm with body warna varying from pale to striking, i.e., white, gray, dark blue, black to red (Coleman et al. 2004). Collembola is tolerant of sour soil so often found in peat soil (Suwondo, 2002). Collembola is commonly found in the top layer of leaf litter, especially from the Entomobrydae type. Collembola can be classified as saprophagus animals. Commonly digested organic matter includes hyphae and fungal spores, plant remains and unicellular green ganggang. Collembola also affects the dynamics of the population of fungi because of its habit of eating hyphae and fungal spores (Gobat et al. 2004).

Soybean (Glycine max L.) is the third most important food crop commodity after rice and corn. Soybeans contain high protein by 30-50%. Soybean is a source of vegetable protein which is very important in order to improve people's nutrition because it is safe for health and cheap (Wahyudin et al, 2017).

The need for soybeans continues to increase from year to year, while the achieved production has not been able to keep up with these needs. The demand for soybeans in Indonesia in 2016 is estimated to reach 2,720,496 tons while production in the same year was only 943,862 tons (Nurhayati, 2016). The Central Bureau of Statistics (2015) stated that soybean production in 2014 was 955.00 thousand tons of dry beans, an increase of 175.01 thousand tons (22.44%) compared to 2013. Soybean production in 2015 was estimated at 998.87 thousand tons of beans dry season or an increase of 43.87 thousand tons (4.59%) compared to 2014. The increase in soybean production is estimated to occur due to an increase in harvested area of 24.67 thousand hectares (4.01%) and an increase in productivity of 0.09 quintals. / Hectare (0.58%) (Central Bureau of Statistics, 2015).

II. Review of Literature

The data obtained (density, biomass and diversity of Collembola) were analyzed using the t-student test.

2.1 Implementation of Research

Land preparation, namely cultivating land then conducted soil analysis is done in the laboratory. The provision of laying hen manure on research land after which organic soybeans are carried out. A week after planting, the extraction of Collembola was carried out.

2.2 Observed Parameters

1. Collembola density by using the following formula:

$$I = \frac{IS}{A}$$

Where: IS: average number of individual soil examples

A: paralon area (^{cm2})*)

I: number of individuals/^{cm2}

*) Paralon area = $^{r2}\ \pi = (10\ cm)^2 \times 3.14 = 314\ cm2 = 0.0314\ m2$

2. Collembola Biomass**.** Biomass calculations are calculated by: Number of samples per per soil fauna x individual weight (reference)

3. Collembola diversity is calculated based on Shannon's Diversity Index formula (Ludwig and Reynolds, 1988):

$$H' = -\sum_{i=1}^{s}\left[\left(\frac{ni}{n}\right) ln \left(\frac{ni}{n}\right)\right]$$

Where: H' = Shannon's Diversity Index
Ni = the number of individuals of a particular fauna
n = the total number of individual fauna in soil examples

The value of H' according to Magurran (1987) ranges from:
< 1.5 = low diversity
1.5 – 3.5 = moderate diversity
> 3.5 = high diversity

III. Result and Discussion

3.1 Collembola population (individual/m2) of Organic Soybean Plants

The results showed that, before planting organic soybeans (early days) and before being given treatment in the form of laying hen manure found the population of Collembola poduridae group only 3 individual/m2. Observations on vegetative and generative masa after treatment there was an increase in Collembola with found 183 individuals / m2 belonging to the group Poduridae, Hypogastruridae, Isotomidae and Entomobrydae. This suggests that the role of organic matter is very real in the increase in the population of Collembola, where the laying hen manure is food rather than soil mesofauna, which is one of them is Collembola. Based on Arief (2001) states that the existence of mesofauna in the soil is highly dependent on the availability of energy and food sources for their lives, such as organic matter and living biomass which are all related to the flow of carbon cycle in the soil. The availability of energy and nutrients for the Collembola, then its development and activity will be good and have a positive impact on soil fertility. Collembola plays a role in the food cycle as an organic or detritivor (Triplehorn and Johnson, 2005). Collembola is widely used as a bioindicator or monitoring of an ecosystem (Migliorini, 2005).

Organic matter, temperature and humidity of air and soil in the forest reserve are low. It is possible that these three factors can also result in the low number of Collembola individuals in the forest reserve. Organic matter, temperature, and humidity can affect the abundance of Collembola (Eaton et al. 2004). Some Collembola species are sensitive to soil moisture so that variations in species composition and populations are different (Irmler, 2004).

Abiotic environmental factors in the research area also supported the number of ground surface Collembola found. Soil moisture, C-organic, ratio of C and N, total N, potassium, and water content in the study area were very high. Kaneda and Kaneko (2004) stated that the growth of Collembola increased in line with the increase in the proportion of soil and sand seen from the amount of N biomass, total C, and total N, soil respiration and C-organic matter. This is consistent with several research results which state that the abundance of Collembola is associated with an increase in litter quantity. Thick and moist litter conditions will provide suitable microhabitat conditions for soil surface Collembola. Thick litter will cause an increase in organic content. This is in accordance with the use of organic matter in the research area is quite good (Rahmadi et al, 2004).

Fitrahtunnisa and Ilhamdi (2013) stated that the abundance of soil arthropods correlated with abiotic environmental factors in each habitat such as litter thickness, soil organic matter content, soil water content, temperature, and humidity. Changes in the composition of floristics or plants in a habitat will affect the abundance of arthropods in it,

which in turn can disrupt the stability of the ecosystem (Trisnawati and Subahar, 2011). Environmental changes will directly or indirectly affect the fauna that inhabit it (Rahmadi and Suhardjono, 2007). The abundance of Collembola is determined by the farming system applied. Agricultural systems with excessive application of pesticides can suppress the Collembola population, on the other hand environmentally friendly agricultural systems, such as organic farming systems will create conditions that support the survival of Collembola. Indriyati and Wibowo (2008) stated that the abundance of Collembola on organic land was higher than on conventional land. The intensive use of insecticides in the implementation of conventional rice cultivation has suppressed the Collembola population.

3.2 Collembola Biomass (mg/m2) in Organic Soybean Crops

The results showed that, before planting organic soybeans (early days) and before being given treatment in the form of laying hen manure found very small Collembola biomass (reference) which is 0.01 mg/m2, namely in Poduridae group. Collembola biomass after treatment in vegetative and generative masa shows a figure of 2.56 mg / m2. Collembola biomass according to the average reference has a very small size, but the role of Collembola in the soil is very important in helping other organisms to It helps in absorbing nutrients through the roots of plants, especially soybean plants. Soil organisms build a symbiotic relationship with the roots of soybean plants and absorb more nutrients. Mycorhiza helps plants to absorb more phosphorus, while Rhizobium helps plants to absorb more nitrogen. Enough nutrients can increase soil organisms, so that large groups of soil fauna (predators) will be aroused by their development because they prey on small soil organisms such as Collembola as a food source (McLeod et al. 2006).

Collembola in soil grows on Mycorhiza and as a control of fungal diseases in some plants. Most of the Collembola populations, including preying on Mycorhiza roots, can stimulate symbiont growth and increase plant growth. Collembola is important in stimulating or suppressing microbial symbiosis around plant roots. Collembola can increase food sources directly in root decay or indirectly in the formation of decomposer fungal hyphae (Sinka et al, 2007). Collembola can also function to reduce the possibility of diseases caused by fungi or fungi. Protaphorura armata Tullberg can play a role in controlling plant diseases caused by the fungus Fusarium culmorum and Gaeumannomyces graminis var tritici (Sabatini et al, 2004). Sminthurus viridis Lubbock is considered a plant pest because it takes food from living plants (Greenslade et al, 2000). Predators can also control Collembola populations. Mites are a group of predators that are important in determining the size of the Collembola population. The second group of predators were Pseudoscorpion, Staphylinidae, Carabidae, and Centipedes, while the third group of predators were ants, spiders, and predatory hemiptera. Collembola produces a chemical substance (methyl acetate) that can be used as a means of defense against predatory attacks (Pfander and Zettel 2004). The pH content in the research area was neutral, this also affected the individual biomass of Collembola soil surface. Collembola is a soil mesofauna whose population is most prominent on land with an acidic soil pH (Coleman et al, 2004).

3.3 Collembola Diversity in Organic Soybean Crops

The results showed that, before planting organic soybeans (early days) and before being given treatment in the form of laying hen manure found the diversity of Collembola with a value of 0 which is classified as Very low. The diversity of Collembola after being given treatment in vegetative and generative times shows the number 0.89 is relatively low. This shows that the diversity of Collembola in organic soybean plants does not affect, because there is only a population of 183 individuals/ m2 and only has a biomass of 2.56

mg / m. 2. The diversity of soil fauna will increase if found various types of soil fauna, especially groups of meso and macro soil fauna. Another thing that greatly affects, namely, the condition of the land at the time of the study in a flooded state, organic material in the form of laying hen manure given to the study. This is reduced so that the value of collembola diversity is low. Sugiarto et al (2002) stated that, the diversity of soil fauna, especially Collembola, is influenced by the variety of food available in the environment. Environments with slow-covering vegetation generally have a large population density due to the availability of food for a long time. Poerwowidodo (1992) states that organic matter has the most productive and active biological activities involving soil fauna.

The mechanism of the faunal food cycle/network in the soil is that the soil mesofauna breaks down coarse organic matter into finer flakes, which then turn into organic colloids so as to provide soil macrofauna nutrients. Soil macrofauna distribute these nutrients to the surrounding soil area thereby stimulating the development of soil microorganisms. Various activities of soil microorganisms, microflora and fauna mutually support the continuity of the nutrient cycle process, forming a biogenic soil structure that regulates the physical, chemical, and biological processes of the soil (Policy Synthesis Team, 2008). Suwondo (2006) states that some Collembola are able to interact with environmental factors. Environmental factors determine the structure of the Collembola community because the Collembola community interacts with each other. Differences in diversity indicate the level of tolerance for the environment. Rahmadi et al (2004) stated that biotic factors also affect the existence of Collembola. Vegetation cover is an important factor because it affects soil conditions and the behavior of soil animals. The evenness index value becomes information on the presence or absence of the dominance of a species. All habitat types have high evenness, all habitats have an even distribution of species and there is no dominance of certain species.

A high diversity index indicates an even abundance of species, while a low diversity index indicates a tendency to dominate certain species (Priyono and Abdullah, 2013). The population of a tribe is not dominant, so the evenness tends to be high. Environmental components affect the evenness of biota, so the high evenness of species can indicate habitat quality (Fachrul, 2012). This study shows the index of species diversity in each habitat is different descriptively. Kamal et al (2011) stated that this is influenced by the food chain, namely the longer the food chain, the higher the evenness index value. Evenness tends to increase following the diversity of habitat structures

The population, biomass and diversity of Collembola greatly affect the level of soil fertility, where the soil fauna in carrying out its activities in the soil has a good impact on the physical, chemical and biological properties of the soil. The life of soil fauna is strongly influenced by biotic and abiotic environmental factors. Biotic environmental factors are the presence of other organisms in the same habitat, such as microflora, plants and other faunal groups. Abiotic environmental factors that affect the presence of soil fauna, especially soil pH, soil temperature, aeration and available water content. Fertile soil with a supportive Collembola population provides good benefits for people who cultivate plants, especially organic soybeans. The benefits obtained are that the cultivated land can be used optimally, the use of fertilizers is given efficiently, the environment is not polluted because the population of organisms in the form of Collembola supports the cultivation environment. Another thing that was obtained was that organic soybean cultivation gave good results, especially for public health (no chemical residues). Organic soybeans when produced provide positive things, namely to the community (currently organic products are preferred) who are more concerned with health.

IV. Conclusion

1. Collembola population in organic soybean plants has a value of 183 individuals / m2.
2. Collembola biomass in organic soybean plants has a value of 2.56 mg / m2.
3. Collembola diversity in organic soybean plants has a value of 0.89 (relatively low).
4. Population, biomass and diversity of Collembola have a good impact on soil fertility, so it is a positive thing for people who cultivate, especially soybeans.
5. Soybean cultivation is an organic product that is good for the community, especially those who currently prioritize health.

References

Apriantono A. (2008). Pertanian Organik dan Revitalisasi Pertanian. http://goorganik.com/mod.php?mod=publisher&op=viewarticle&cid=6&a rtid=9. [7 Maret 2021]

Arief A. (2001). Hutan dan Kehutanan. Yogyakarta: Kanisius

Badan Pusat Statistik. (2015). Data Produksi Tanaman Jagung, Padi dan Kedelai. Sumatera Utara. Medan

Coleman DC, Crossley DA and Hendrix PF. (2004). Fundamentals of Soil Ecology. London: Academic Press

Eaton RJ, Barberchek M, Buford M, Smith W. (2004). Effect of organic matter removal, soil compaction, and vegetation control on Collembola population. Pedobiologia 48:121-128

Fachrul, M.F. (2012). Metode sampling bioekologi. Edisi 1 Cetakan III. Jakarta: Bumi Aksara

Fitrahtunnisa dan Ilhamdi, M.L. (2013). Perbandingan keanekaragaman dan predominansi fauna tanah dalam proses pengomposan sampah organik. J. Bumi Lestari, 13(2), 413-421

Gobat JM, Aragno M, Matthey W. (2004). The Living Soil: Fundamentals of Soil Science and Soil Biology. USA: Science Publishers, Inc

Greenslade P, Deharveng L, Bedos A, Suhardjono YR. (2000). Handbook to Collembola of Indonesia. Cibinong: Fauna Malesiana (Draft final).

Kaneda S, Kaneko N. (2004). Growth of the Collembolan Folsomia candida Willem insoil supplemented with glucose. Pedobiologia 48:165-170

Imler U. (2004). Long-term fluctuation of soil fauna (Collembola and Orabatida) at ground water-near site in an alder wood. Pedobiologia 48:349-363

Indriyati dan Wibowo, L. (2008). Keragaman dan kemelimpahan Collembola serta Arthropoda tanah di lahan sawah organik dan konvensional pada masa bera. J. HPT Tropika, 8(2), 110-116

Kamal, M., Yustian, I. dan Rahayu, S. (2011). Keanekaragaman jenis Arthropoda di Gua Putri dan Gua Selabe kawasan karst Padang Bindu, OKU Sumatera Selatan. Jurnal Penelitian Sains, 14(1), 33- 37

Ludwig AJ, Reynolds FJ. (1988). Statistical Ecology: A Primer on Methods and Computing. New York: J Wiley

McLeod, LinesKelly, Tinning, Slavichand Moore. (2006). Soil organisms: benefits and management practices. Australia: NSW Department of Primary Industries

Migliorini M, Pigino G, Caruso T, Fanciulli PP, Leonzio C, Bernini F. (2005). Soil communities (Acari Oribatida; Hexapoda Collembola) in a clay pigeon shooting range. Pedobiologia 49: 1-13

Nurhayati. (2016). Pengaruh Jenis Amelioran Terhadap Efektivitas dan Infektivitas Mkiroba pada Tanah Gambut dengan Kedelai sebagai Tanaman Indikator. Jurnal Floratek, 6,124-139

Poerwowidodo. (1992). Metode Selidik Tanah. Surabaya:Penerbit Usaha Nasional

Priyono, B. dan Abdullah, M. (2013). Keanekaragaman jenis kupu-kupu di Taman Kehati UNNES. Biosaintifika, 5(2), 76-81

Rahmadi C, Suhardjono YR, Andayani I. 2004. Collembola lantai hutan di kawasan hulu Sungai Tabalong Kalimantan Selatan. Biota IX:179-185

Rahmadi, C. & Suhardjono, Y.R. (2007). Arthropoda gua di Nusakambangan Cilacap, Jawa Tengah. Zoo Indonesia, (16):21-29

Sabatini MA, Ventura M, Innocenti G. (2004). Do Collembola affect the competitive relationships among soil-borne plant pathogenic fungi? Pedobiologia 48:603-608

Sinka M, Jones TH, Hartley SE. (2007). the indirect effect of above-ground herbivoryin Collembola populations is not mediated by changes in soil water content. Appl Soil Ecol 36:92-99

Sugiyarto, Wijaya D, Suci YR. (2002). Biodiversitas hewan permukaan tanah pada berbagai tegakan hutan di sekitar gua Jepang, BKPH Nglerak, Lawu Utara, Kab. Karang Anyar. Biodiversitas 3(1):196-200

Sutanto. (2002). Penerapan Pertanian Organik, Pemasyarakatan & Pengembangannya. Yogyakarta: Kanisius

Suwondo. (2002). Komposisi dan Keanekaragaman Mikroarthropoda Tanah sebagai Bioindikator Karakteristik Biologi pada Tanah Gambut. http://www.unri.ac.id/jurnal/jurnal_natur/vol4%282%29/suwondo.pdf.Diakses pada Februari 2022

Tim Sintesis Kebijakan. (2008). Pemanfaatan Biota Tanah untuk Keberlanjutan Produktivitas Pertanian Lahan Kering Masam. Pengembangan Inovasi Pertanian 1 (2), 2008: 157-163. Balai Besar Penelitian dan Pengembangan Sumberdaya Lahan Pertanian, Bogor

Triplehorn CA, Johnson NF. (2005). Borror and Delong's Introduction to the Study ofInsects 7 ed. USA: Brooks Cole

Trisnawati, I.D.T. dan Subahar, T.S. (2011). Kelompok trofik pada komunitas arthropoda tajuk dan lantai hutan di Hutan Gunung Tangkubanparahu-Jawa Barat: Ilustrasi dengan Diagram Trofik Hipotetik. Berkala Penelitian Hayati, 17: 119–125

Wahyudin, A., F.Y. Wicaksono, A.W. Irwan, Ruminta, dan R. Fitriani. (2017). Respon tanaman kedelai (Glycine max) varietas Wilis akibat pemberian berbagai dosis pupuk N, P, K, dan pupuk guano pada tanah inceptisol Jatinangor. Jurnal Kultivasi 16(2): 333-339

Zalilani, M. et al. (2019). Growth Response and Crop Production (Brassica Juncea L.) Against Watering Time Interval at Various Hydroponics Media. Budapest International Research in Exact Sciences (BirEx) Journal.P. 9-22.