SOIL MACROFAUNA AND MESOFAUNA COMMUNITY ON AGRICULTURAL LAND IN PLIKEN VILLAGE, KEMBARAN DISTRICT, BANYUMAS REGENCY

Susanto, Satrio Krisna Haryanto, Dyah Ratna Sari
Biology Education Program, Faculty of Education Muhammadiyah Purwokerto University
Corresponding Author : susanto280266@gmail.com

ABSTRACT

Soil is a habitat for various types of fauna, especially macrofauna and soil mesofauna. In general, fertile soil can be found on land used for agricultural activities. The purpose of this study was to determine and reveal the community structure of soil macrofauna and mesofauna which includes individual count, diversity, and dominance as well as environmental quality on agricultural land in Pliken Village, Kembaran District, Banyumas Regency in 2021. The study was carried out in January-June 2021. by using survey method and purposive random sampling technique. Sampling of soil macrofauna and mesofauna was carried out in three locations, namely agricultural land in the west, north, and south of the village. Data sampling was carried out in the morning (07.00-09.00 am) and at night (19.00-21.00 am) 6 times with an interval of once a month. Soil macrofauna and meofuana that had been obtained were identified using the Taxonomy and Identification Key book. An Introduction to the Study of Insects and other references related to the identification of soil macrofauna During the study, 2717 soil macrofauna were found which belong to 15 Orders, 31 Families and 40 Species, while for soil mesofauna, 500 individuals were obtained which belong to 14 Orders, 18 Families. and 21 species.The highest individual count for soil macrofauna came from the Formicideae family (86.86%), while the highest individual count for soil mesofauna came from the Isotomideae family (27%). The index of soil macrofauna diversity on agricultural land in Pliken Village ranged from 0.997- 1,789 with an average of 1,287 which means the level of diversity is moderate, while the index Soil mesofauna diversity ranges from 1.13 to 2.15 with an average of 1.65 which means the level of diversity is moderate. Soil macrofauna dominance index is moderate with a range of 0.264 - 0.546 which indicates that there is still dominance by certain soil macrofauna, namely the Formicideae (ant) family, while the soil mesofauna dominance index ranges from 0.13 to 0.38 with an average of 0.23 which indicates the absence of a predominant species. The environmental quality of agricultural land in Pliken Village is categorized as good to support the life of macrofauna and soil mesofauna.

Keywords : Soil Macrofauna, Soil Mesofauna, Individual Count, Diversity, Dominance, Pliken Village Agricultural Land

Diterima: 30 Mei 2022 ***Diterbitkan: 28 Juni 2022***

INTRODUCTION

Pliken Village is one of the villages located in central Java Province, precisely in Twin Districts, Banyumas Regency. Pliken village has several potentials such as in the agricultural sector, livestock, trade and other small industries. One of the most prominent potentials is in the agricultural sector. In the agricultural sector, rice becomes the leading commodity. According to Bambang (2016) Pliken Village became the main contributor of rice crops in Twin Districts, reaching 2,874 tons of total rice harvest of 19,463 tons. Pliken village has the potential of a viable agricultural sector. This makes the average plikenvillagers livelihood as farmers.

Farmers in Pliken Village used to use agricultural land in the form of rice fields that they owned for crop cultivation. Plants commonly cultivated in rice fields in Pliken Village in the form of rice and palawija plants such as corn and beans. Before the farmers

planted the rice fields, farmers first processed the rice fields by ploughing. Rice fields are the most important part of the ecosystem, because rice fields are the main natural resources in cultivating crops, especially rice and palawija plants. Directly or indirectly, the presence of soil fauna communities such as soil macrofauna affects the state of the environment around them. This happens because in the practiceofivity to meet the needs of his life, designis very dependenton the environment. The environment provides all the resources needed for every type of soil fauna that inhabits the environment. The activity of soil macrofauna in processing existing resources in an environment also helps the environment to be able to provide its carrying capacity to other living things. For example, the activity of the soil macrophage community on a farm that is believed to affect the fertility rate and productivity of the soil on the land so as to support plants to thrive.

Agriculture in pliken village is done traditionally starting from the technique of farming to the materials used for farming. With the development of science and technology and the number of people make the need increasing. Therefore, farmers use non-organic fertilizers so that the results from rice-grown land increase. However, the use of organic fertilizers for a long time causes problems, especially a decrease in fertility rates and a decrease in the quality of the agricultural environment (Roidah, 2013).

The soil of the rice fields there are various kinds of soil fauna. Soil fauna has a function as a soil bioindicator, because it has a very important role in processing soil, is good related to the nature of soil that has functions in the environment, namely storing water, decomposition, and nutrient cycles, neutralizing toxic materials and suppressing other organisms to harm the soil (Damayanti, 2011).

Research on the structure of macrofauna and mesofauna communities on agricultural land in Pliken Village, Kembaran Districts, Banyumas Regency was conducted by identifying and quantifying macrofauna and soil mesofauna and explaining the relationship of environmental factors with the level of diversity, abundance, and dominance of soil macrofauna communities on agricultural land.

The formulation of the problem in this study is How is the community of macrofauna and mesofauna land that includes individual, keanakeragaman, dominance and environmental quality on agricultural land in PlikenVillageKembaran DistrictsBanyumas Regency? The purpose of this study is to find out and uncover the mesofauna community of land that includes individual , diversity, dominance and environmental quality on agricultural land in Pliken Village twin district of Banyumas Regency.

RESEARCH METHODS

The research was conducted on agricultural land located in three different locations in Pliken Village, Twin Districts, Banyumas Regency.

The study was conducted for six months, namely in January - June 2021. This time is considered the most effective to carry out this study with consideration of the rainy season (January-March) and the dry season (April-June). Sampling is done at intervals of one month and consideration of morning time (07.00-09.00) and at night (19:00- 21:00).

The method used in this study is a survey method with purposive random sampling technique. According to Sugiyono (2010) purposive random sampling technique is a technique to determine research samples with certain considerations that aim so that the data obtained later can be more representative. Considerations when sampling in this study are based on the time and representation of samples for each location. Consideration of sampling time is the time of day to find out the soil macrofauna that are active during the day (diurnal) and at night to find out macrofauna and soil mesofauna that move at night (nocturnal). In addition, sampling also considers two seasons in Indonesia, namely the rainy season in January-March and the dry season in April-June.

RESULTS AND DISCUSSIONS

Number of Individuals and Types of Soil Fauna

The number of individual macrofauna land obtained during the study in January to June 2021 on the agricultural land of Pliken Village banyumas regency area is as many as 2717 tails which belong to 15 orders, 31 families and 40 species. While the number of individuals mesofauna land obtained during the study is as many as 500 tails that belong to 14 Orders, 18 Families and 21 Species. The most widely found species of soil mesofauna species is *isotomurus*sp species which numbers 133 tails, while for the second most acquisition is the species predatory fleas (Asca*vulgaris).* According to Susanto (1994) states that the Collembola and Acarina orders are the most widely found orders in various habitats, with varying numbers both in the rainy season and in the dry season.

Tabel 1. Individual and variations of soil macrofauna species (A) and soil mesofauna (B) obtained during the study (January – June 2021).

NO	Ordo	Family	Spesies	Nama Lokal	Cacah Individu
1	Hymenoptera	Formicidae	*Anoplolepsis* sp.	Semut kuning	1344
			Dolichoderus sp.	Semut hitam	387
			Camponotus sp.	Semut tukang kayu	512
			Atta sp.	Semut pemotong daun	3
			Lasius sp.	Semut kebun	113
		Eumenideae	*Pachodynerus* sp.	Tawon	1
		Carabideae	*Tanystoma* sp.	Kumbang tanah	119
2	Coleoptera	Dermestideae	*Attagenus* sp.	Kumbang bulu atau kumbang permaidani	1
			Dermestes sp.	Kumbang dermestid atau kumbang kulit	2
		Lampyrideae	*Nyctophila* sp.	Kunang-kunang	1
		Dynastideae	*Heteronychus* sp.	Kumbang Jagung Hitam	1
		Staphylinideae	*Paederus* sp.	Tomcat	3
		Curculionidae	*Cyrtepistomus* sp	Kumbang penggerek hidung lebar	2
3	Orthoptera	Gryllotalpideae	*Gryllotalpa* sp.	Orong-orong	12
		Gryllidae	*Gryllodes* sp.	Jangkrik Tropis	73
			Acheta sp.	Jangkrik rumah	2
			Eumesobius sp.	Jangkrik tanah	9
			Phyllopalpus sp.	Jangkrik semak berkepala merah	1
4	Isoptera	Acrididae	*Amblytropidia* sp.	Belalang	1
		Rhinotermitideae	*Reticulitermes* sp.	Rayap	7
5	Diptera	Calliphoridae	*Chrysomya* sp.	Lalat	5
		Drosophilideae	*Drosophila* sp.	Lalat buah	13
		Platystomatidae	*Pegomertalis* sp.	Lalat sinyal	1
6	Hemiptera	Cydnideae	*Sehirus* sp.	Kepik atau Kumbang penggali	2
		Rhyparochromideae	*Beosus* sp	Kutu benih	1
7	Dermaptera	Forficulideae	*Forficula* sp.	Cocopet	1
8	Araneae	Salticideae	*Simicus* sp.	Laba-laba peloncat	8
		Amphaenideae	*Hibana* sp.	Ghost spiders	59
		Thomisideae	*Misumena* sp.	Laba-laba kepiting	1
		Pisauridae	*Dolomedes* sp	Laba-laba memancing	1
9	Haplotaxida	Lumbricideae	*Lumbricus* sp.	Cacing tanah	5
10	Polydesmida	Paradoxosomatideae	*Oxidus* sp.	Ulat kaki seribu	2
11	Anura	Eleutherodactylideae	*Adelophryne* sp.	Katak sawah	1
		Dicroglossideae	*Fejervarya* sp	Katak tegalan	1
12	Blattodea	Ectobiideae	*Blattella* sp.	Lipas atau kecoa	1
			Ischnoptera sp.	Kecoa kayu	1
13	Decapoda	Gecarcinucideae	*Parathelphusa* sp.	Yuyu sawah	1
14	Architaenioglossa	Ampullariideae	*Pila ampuliceae*	Keong mas	9
15	Stylommatophora	Camaenideae	*Bradybaena* sp.	Keong semak	9
		Achatinideae	*Achatina* sp.	Bekicot	1
Total Individu					2717

(A)

Ordo	Famili	Spesies	Nama Lokal	Total
Diptera	Drosophilideae	*Drosophila* sp.	Lalat Buah	47
Sarcoptiformes	Acarideae	*Acarus siro*	Kutu Tepung	15
Collembola	Isotomideae	*Isotomurus* sp.		133
	Entomobrydeae	*Entomobrya sicia*		3
Hymenoptera	Formicideae	*Solenopsis invicta*	Semut Merah	26
		Dolichoderus thoracicus	Semut Hitam	26
Acarina	Ascideae	*Asca vulgaris*	Kutu Predator	115
Thysanoptera	Thripideae	*Thrips* sp.	Hama Putih	40
Diplura	Japygideae	*Japyx* sp.		30
Ixodida	Ixodideae	*Ixodes holocyclus*	Kutu Tanah	2
Coleoptera	Anobiideae	*Stegobium paniceum*	Hama Bubuk Ketumbar	3
	Carabideae	*Omus californicus*	Kumbang macan	8
		*Amblytelus*sp.	Kumbang	1
		Notiophilus biguttatus	Kumbang Tanah	4
Siphonaptera	Pulicideae	*Ctenocephalides felis*	Kutu kucing	4
Hemiptera	Aleyrodideae	*Bemisia* sp.	Kutu kebul	1
	Aphidideae	*Aphis* sp.	Kutu Daun	3
	Cimicideae	*Cimex lecturarius*	Kutu Busuk	5
Aranae	Araneideae	*Araneus* sp.	Laba-laba	20
Orthoptera	Gryllideae	*Grillodes* sp.	Jangkrik	2
Protura	Acerentomideae	*Acerentulus* sp.		12
14 Ordo	18 Famili	21 Spesies		500

(B)

This is likely because both orders have an important role in the process of remodeling organic matter and the process of soil formation. Because it is found in various lands, the Collembola Order is thought to have good adaptations and can survive in dry land conditions though.

Diversity

Based on the results of research, both in the rainy season and the dry season show the value of the diversity index that is fluctuating. The results of measurements of soil macrofauna diversity index in the rainy season based on Shannon Winner diversity index criteria show an average level of moderate diversity with index values that are decreasing towards the dry season. The average value of the diversity index in the rainy season, namely the period of January to March is higher than in the dry season of the period april - June. In the rainy season shows an average result of diversity index of 1.41595. Meanwhile, the dry season of the diversity index showed an average yield of 1.15777. The results are not much different from Aminullah et al., (2015) in his research on the diversity of soil macrofauna on semi-organic and non-organic agricultural land found the value of the diversity index in the range of 1.4848 - 1.7195.

While the results of the measurement of the diversity index of soil mesofauna in the rainy season based on the criteria of the Shannon Winner diversity index showed an average level of moderate diversity with an index value that decreased towards the dry season. The average value of the diversity index in the rainy season, namely the period of January to March is higher than in the dry season of the period april - June. In the rainy season shows an average yield of diversity index of 1.51. Meanwhile, the dry season of the diversity index showed an average yield of 0.68. The results are in accordance with those expressed by Lestari (2021) stating that the abundance of soil mesofauna will decrease in the dry season because the higher the air temperature, the lower the level of the soil mesofauna population.

Dominance

The index of soil macrofauna dominance of all research sites showed results ranging from 0.26358 (january) - 0.40046 (in March) in the rainy season. During the dry season ranges from 0.32813 (may) - 0.54608 (april). Inthe

rainy season in January to March shows the existence of a more domineering species that comes from the family formicideae consisting of ant species *Anoplolepsis*sp. *Dolichoderus* sp.And *Camponotus* sp.

Similarly, in the dry season in April to June, which is also still found species dominance. The species that characterizes in the dry season comes from the ant species *Anoplolepsis* sp. The existence of dominance can be seen in the acquisition of the value of the dominance index of these species which is higher among other species, which is getting closer to 1.

The existence of species dominance is believed to be influenced by the acquisition of the average diversity index value that shows the level of diversity that is still classified as moderate according to the criteria of the Shannon Winner diversity index because the value > 1 but still < 3. The still level of diversity in a community shows that there is still a lack of stability in the community due to the presence of certain species that are more criminalized or uneven distribution of the number of species.

While the dominance index on land mesofauna by season, the dominance index in the rainy season ranges from 0.21 - 0.56 with an average of 0.36 while in the dry season the index of soil mesofauna dominance ranges from 0.11 - 0.86 with an average of 0.46. This shows that the dominance index on Agricultural Land in Pliken Village of Twin Districts of Banyumas Regency includes low criteria. According to Erniyani et al., (2015) stated that if the dominance index is getting smaller then it shows the composition of fauna in the soil is more balanced.

Environmental Factors

Air Temperature

Based on the results of air temperature measurements based on time shows a higher average measurement results during the day. During the day, the air temperature on agricultural land in Pliken Village ranges from 27-28 o C. While at night, the temperature ranges from 26.5-27 o C. The difference occurs because during the day the irradiation of sunlight makes the surface area of the farm becomes warmer. According to Halim (2019) stated that the temperature that affects soil mesofauna in the development of life is ranging from 15-40 ℃, while the optimum temperature for breeding soil mesofauna is 25 ℃.

Soil Temperature

The average soil temperature on Pliken Village Farmland is seen based on the overall season ranging from 23-28˚C to an average of 26.03 ˚ C. The average soil temperature based on overall sampling time ranges from 23-29˚C with an average of 25.6 ˚C. The average soil temperature based on the overall sampling location is ranging from 23-29˚ C with an average of 25.25˚C. According to Muli et al., (2015) stated thatthe optimum temperature for soil fauna andliving animals is at a temperature of 28˚C- 32℃.

Land pH

The pH of the soil indicates the level of acidity or numbness of the soil. Soil pH measurement is very important in soil animal ecology because the presence and density of soil animals is highly dependent. at ph soil (Suin, 2012). From the resultsSoil pH measurements show the average pH of soil on agricultural land in Pliken Village shows a value range of 6.6-6.7. The pH value is the pH value of the acid but is close to neutral. According to the Buleleng District Agriculture Office Team (2021) soil pH which is at 6.5 to 7.8 is an ideal pH to keep the content of organic compounds, microorganisms, nutrients and minerals in optimal conditions. According to Nurrohman et al., (2015) stated that most soil fauna feeding pH ranges from 6-7 due to the high availability of nutrients. The pH condition of soil that is too acidic and alkaline can interfere with the life of soil fauna.

Soil Moisture

Soil moisture measurement is done with the help of a soil tester. In the tool shows the scale of soil moisture that ranges from 0-100. According to Lolok (2020) the value of humidity based on the results of measurements using soil testers is divided into three parts, namely dry or dry with a range of 0% - 30%, moist with a range of 40% - 60%, and wet with a range of 70% - 100%. From the results

of soil moisture measurements using soil testers on agricultural land known in the rainy season in January to March, soil moisture ranges from 60-65%. This value is higher than the measurement results in the dry season in April to June which only ranged from 40%-55%. Measurable soil moisture during the day generally showed a lower percentage value than at night at each research site.

According to Nurrohman et al., (2015) stated that soil moisture has an important role in determining the level of diversity in a community. Humidity provides a more critical effect on an organism at extreme high or extreme low temperatures in addition to high humidity is also better for soil animals than low humidity.

Soil Texture

Soil texture is one of the factors that affect the life of soil fauna. To find out the texture of the soil contained at the research site, then each location used for sampling is sampled soil and analyzed by manual means of hand groping taste. Then analyze further using a triangle of textures. Measurement of soil texture begins by taking soil samples at each research site which is then distinguished by manual means by hand. Next analyzed by looking at the triangle of textures.

The results of the analysis of soil texture classes showed that in the rainy season from January to March 2021, the average soil texture on wet farmland planted with rice is clay, while on dry agricultural land planted with various crops palawija is sandy clay. Then in the dry season of april to June 2021, the average soil texture is not much different, in wetlands planted with rice plants have a clay texture but with a more tenuous soil structure to form cracks. Such structures occur because high temperatures in the dry season increase the process of evaporation of water in the soil which causes the water content to decrease so that the density of the soil begins to decrease also which is characterized by the formation of soil cracks. While on dry land has the texture of sandy clay soil.

According to Isra et al., (2019) states that the texture shows the smooth or coarse nature of soil grains seen by the balance of content between *sand (sand)* clay*(clay)* and dust *(slit)* found in the soil. Based on the results obtained for the rainy season (January-March) dry season (April-June). For locations 1, 2 and location 3 on average have a clay texture and sandy clay. The texture of clay soil is characterized by not feeling rough and not slippery, somewhat attached, can be formed the ball is rather firm, and can be slightly made gulungan with shiny surface. While the texture of sandy clay soil is characterized by rough soil felt clear, slightly attached, and can be formed balls but easily destroyed. The results of the analysisof soil texture arepresented in table 2.

Table 2. Soil texture analysis on Januari-Juni

Lokasi	Stasiun	Tekstur Tanah
Lokasi 1	Stasiun 1	Lempung
	Stasiun 2	Lempung
	Stasiun 3	Lempung berpasir
Lokasi 2	Stasiun 4	Lempung berpasir
	Stasiun 5	Lempung
	Stasiun 6	Lempung
Lokasi 3	Stasiun 7	Lempung berpasir
	Stasiun 8	Lempung berpasir
	Stasiun 9	Lempung
	Stasiun 10	Lempung

CONCLUSION

Based on the research that has been done, the following conclusions have been obtained:

1. The structure of the macrofauna community and mesofauna land on the Agricultural Land of Pliken Village of Twin District consists of:

a. The number of macrofauna individuals obtained for six months (January-June) conducted research on the Agricultural Land of Pliken Village twin districts of Banyumas Regency, namely as many as 40 species that belong to 15 orders, 31 families with a total of 2717 tails. Members of the Formicideae (ants) are the largest constituent community (86.86%). While the number of mesofauna individuals obtained during the study is as many as 21 species, which belong to 14 Orders, 18 Families with an individual number of 500. Members of the Isotomideae are the largest constituents (27%).

b. Diversity of soil macrofauna species on agricultural land in Pliken Village in 2021 is categorized as low to moderate with a diversity index value of 0.997-1.780. This is influenced by the spread of the number of individuals that have

not been evenly distributed as a whole and the influence of human activities in cultivating agricultural land. While the diversity of land mesofauna in Pliken Village Agricultural Land of Banyumas Regency Twin District based on Shannon Wiener criteria shows moderate diversity with diversity index ranging from 1.13-2.15 with an average of 1.65 which means it has moderate variation and diversity of soil mesofauna with few species and uneven distribution numbers.

c. The dominance of land macrofauna on Agricultural Land in Pliken Village in 2021 is classified as moderate with a dominance index range of 0.264-0.546. Soil macrofauna that still tend to dominate from the research site come from the Formicideae family (ants). While dominansi mesofauna land based on Simpson criteria including low criteria with index values ranging from 0.13-0.38 with an average of 0.23 indicating the absence of dominating species, because D < 0.5.

2. The quality of the soil environment on The Pliken Village Farmland of Banyumas Twin Districts which includes air temperature, soil temperature, pH, moisture and soil texture is considered good for the life of macrofauna and soil mesofauna.

REFFERENCES

Aminullah, Y., N. Mahmudati, dan S. Zaenab. 2015. Keanekaragaman Makrofauna Tanah Daerah Pertanian apel Semi Organik dan Pertanian ApelNon-Organik Kecamatan Bumiaji Kota Batu Sebagai Bahan Ajar Biologi SMA. ***Jurnal Pendidikan Biologi Indonesia***. 1 (2) : 178-187.

Bambang. 2016. Pemetaan Potensi Desa di Kabupaten Banyumas. ***Ecces.*** 2 (3):138.

Damayanti, D. 2011. ***Peingkatan Populasi dan Keanekaragaman Fauna Tanah Melalui Pengelolaan Hayati Tanah Pada Budidaya System Of Rice Intensification (S.R.I.) di Kecamatan Cibungbulang, Kabupaten Bogor***. Skripsi. Fakultas Pertanian. Institut Pertanian Bogor. Bogor.

Erniyani, K., S. Wahyuni, dan Y. M. S. W. Pu'u. 2010. Struktur Komunitas Mesofauna Tanah Perombak Bahan Organik Pada Vegetasi Kopi dan Kakao.***AGRICA.*** 3(1) : 1-8.

Halim, A, A. 2019.***Kepadatan Serangga Tanah di Cagar Alam Gunung Abang dan Kebun Apel KecamatanPuspoKabupatenPasuruan.***Skripsi. Jurusan Biologi Fakultas Sains dan Teknologi Universitas Islam Negeri Maulana Malik Ibrahim Malang. Malang.

Isra, Nur., S.A. Lias., dan A. Ahmad. 2019. KarakteristikUkuranButir Dan Mineral Liat Tanah Pada KejadianLongsor (Studi Kasus : Sub DAS Jeneberang). ***JurnalEcosolum,*** 2(8) : 62-73.

Lestari, E. 2021. ***Keanekaragaman Mesofauna Tanah Dan Karakter Kimia Tanah Pada 2 TipePenutupan Lahan Di Kawasan Kampus UIN Suska Riau.***Skripsi. FakultasPertanian dan Peternakan. Universitas Islam Negeri Sultan Syarif Kasim. Pekanbaru.

Lolok, R. 2020. Alat Sensor Soil Tester. Universitas Sanata Dharma.Yogyakarta.

Muli, R., C. Irsan dan Suheriyanto. 2015. Komunitas Arthopoda Tanah di Kawasan Sumur Minyak Bumi di Desa Mangunjaya, Kecamatan Babat Toman, Kabupaten Musi Banyuasin, Provinsi Sumatera Selatan. ***JURNAL ILMU LINGKUNGAN***. 13(1) : 1-11.

Nurrohman, E., A. Rahardjanto, dan S. Wahyuni. 2015. Keanekaragaman Makrofauna Tanah di Kawasan Perkebunan Coklat (*Theobroma cacao* L.) Sebagai Bioindikator Kesuburan Tanah dan Sumber Belajar Biologi. ***JURNAL PENDIDIKAN BIOLOGI INDONESIA.*** 1(2) : 197-208.

Roidah, I. S. 2013. Manfaat Penggunaan Pupuk Organik Untuk Kesuburan Tanah. ***Jurnal Universitas***

Tulungagung BONOROWO. 1(1) : 30-42.

Sugiyono. 2010. ***Metode Penelitian Kuantitatif, Kualitatif dan R&D***. Alfabeta. Bandung.

Suin, N. M. 2012. ***Ekologi Hewan Tanah.*** Bumi Aksara: Jakarta.

Susanto. 1994. ***Komunitas Fauna Tanah pada Lahan Bekas PembuatanBata.*** Tesis. Program Studi Biologi Jurusan Ilmu-ilmu Matematika dan Pengetahuan Alam Program Pasca Sarjana Universitas Gadjah Mada. Yogyakarta.

Tim Dinas Pertanian Buleleng. 2021. Pengaruh PH terhadap Pertumbuhan Tanaman. distan. Bulelengkab.go.id. Diakses Juli 2021.