Journal of Biotropical Research and Nature Technology
Volume 1 Issue 2 (2023).
Doi : 10.52850/borneo

Research Article

Growth Response of Some Leguminous Plants to Peat Water from Central Kalimantan

Decenly*, Fandi Tuju, Rahayu Opi Anggoro
Department of Biology, Faculty of Mathematic and Natural Sciences, Universitas Palangka Raya, Central Kalimantan, Indonesia

*Email: decenlycenly10@gmail.com; decenly@mipa.upr.ac.id

Keywords:
Leguminous
Peat water
growth response
Germination

Informasi Artikel:
Submitted:
22 Desember 2022
Revised:
23 April 2023
Accepted:
25 April 2023

Abstract
Legumes are cultivated plants that are widely used by the community. In central Kalimantan, especially in Palangka Raya city, the legume is planted by the community as a garden plant which is consumed daily. The condition of acidic peatlands in Central Kalimantan is a limiting factor for plant growth. This study aims to determine the effect of peat water from the Sabangau River in Central Kalimantan on the germination of legume plants. The study used 4 (four) types of plants such as Vigna radiata L, Vigna unguiculata L, Phaseolus vulgaris L, and Glycine max L using a Completely Randomized Design (CRD). The plant seeds were first soaked in peat water for 3 (three) hours, then transferred to a medium covered with cotton and watered using the same water. Observations were made from the first day to the seventh day. Statistical tests used One Way ANOVA analysis to compare the significance between treatments. The results showed that 3 (three) types of plants, namely green beans, long beans, and chickpeas, were able to grow using peat water media, while soybeans could not germinate. Of the three types of plants, mung beans have a better growth rate than long beans and chickpeas. The highest average length of green sprouts is on the seventh day, above 4.14 cm, while in long beans it is 2.32 cm and peas are around 2.04 cm. Statistical analysis using the One Way ANOVA test showed there was no significant difference between the growth of the three types of plants where the significance value was 0.069 (>0.05), but there was a significant difference between the three types of plants that grew when compared to soybeans that were unable to grow with a significance value of 0.01.

Introduction

Taxonomically, legumes belong to the Leguminosae tribe. The Leguminosae tribe generally has fruit called pods. The pods come from a pseudo septum leaf, in the abdominal cavity containing the seeds. This kind of nut contains high protein depending on the type of bean and its variety (Pratiwi et al, 2018). The high protein content makes legumes a potential alternative food for the community (Jacob, 2016). In addition, legumes, especially *Vigna radiata* L, contain nutrients in the form of vitamin C, phytosterols, flavonoids, phenols, selenium, manganese, copper, zinc, and iron and fiber (Lestari et al, 2019).

Germination is the initial stage of the development of a plant, especially legumes. At this stage, the embryo inside the seed which was originally in a dormant condition undergoes several physiological changes so that it develops into a young plant called a sprout. Germinated seeds are

characterized by the appearance of the radicle and plumule. Germination is the process of developing embryos and seed components that can grow normally into new plants. Seed germination is an indicator of seed quality. Seed germination, which is a measure of seed viability, is highly dependent on environmental conditions. The viability of these seeds can be grouped based on their environmental suitability, namely seed viability in favorable environments and seed viability in unfavorable environments. One of the external environmental factors that greatly determine germination as an indicator of seed viability is the test substrate (Nurhafidah *et al*., 202; Felania, 2017).

The germination process is strongly influenced by the growth medium (Adesoye *et al*., 2010). The main thing is the availability of water in the growth medium to stimulate the activity of enzymes needed in the metabolism of germination in the tissues in the seed. The germination phase begins with imbibition which makes the seed coat soft and increases enzymatic activity. During germination, water imbibition stimulates gibberellin activity which is required to activate the αamylase enzyme. This enzyme then enters the food reserves and catalyzes the process of changing food reserves, starch into sugar which is then used as an energy source for cell division and growth (Junaidi, 2021). Germinated seeds cannot yet synthesize their food reserves. The need for carbohydrates is obtained from food reserves (endosperm). Generally, food reserves in seeds are in the form of starch (starch). Starch cannot be transported to other cells, therefore it must first be converted into a form of water-soluble sugar (Dwidjosoeputro, 1978; Fatiqin et al. 2019).

Based on research conducted by Rajab (2016), it is known that different types of water affect the process of growth and development of green bean plants. The response of plant growth varies depending on the type of water used. One type of water suitable for watering mung bean plants is rainwater. In line with this, the results of research by Nasrul (2014) that differences in water temperature have a significant effect on maximum growth potential, germination, and growth simultaneity but have no significant effect on growth speed and vigor index.

The Central Kalimantan region is dominated by peat areas covering an area of 2,162,000 hectares or around 11.7% of Indonesia's total peatlands. Peatlands contain 15.99% Aluminum and 3.7% iron (Ramdhani et al, 2009). Peat water is surface water found in peatland areas. Peat water is a type of water that has a very high organic content (Frank, 2013). This causes the red-black water content. Peat water has a low pH level of around 3-4 with high levels of iron and manganese (Sutapa, 2014).

Water is one of the factors that influence the success of germination (Nugraheni et al, 2018). In the process of growth, aquatic plants play an active role (Trimayora et al, 2021). Lack of water will cause physiological stress on plants (Ntombela, 2012). Peat water with low pH levels is one of the limiting factors for plant germination. This is related to the role of enzymes in the germination process. Low acidity levels can inhibit the performance of enzymes. Therefore it is necessary to research the effect of water on plant germination rates. The purpose of this study was to find out how the germination rate of legume plants was related to the application of peat water in the planting medium.

Materials and Methods

This research was conducted on November 15-30 2022. At the Biology Laboratory, Faculty of Mathematics and Natural Sciences. Palangka Raya University, Central Kalimantan. The tools used in this study included: 20 plastic glass cups, cotton wool, label paper, tweezers, a ruler, an observation sheet, and stationery. Meanwhile, the materials used were: *Vigna unguiculata* L, *Vigna radiata* L, *Glycine max* L, and *Phaseolus vulgaris* L seeds each of 5 (five) grains, and the peat water used came from the Sabangau river which is located in Kereng Bangkirai, Palangka Raya City.

The parameters observed in this study were: 1. The number of germinated seeds, counted the number of seeds that had started to germinate. 2. Sprout Length (cm), measured from the base to the growing point of the plant. 3. Number of leaves (strands), counting the number of leaves that are perfectly formed. This research was carried out using a Completely Randomized Design (CRD)

Factorial with 4 treatments and 5 replications. The data obtained were analyzed using the One Way ANOVA statistical test to compare the significance between treatments.

Results and Discussion

Germination

In the process of germination, water plays an important role in supporting and activating embryonic cells in the seed, softening the seed coat and causing the embryo and endosperm to expand, facilitating the entry of oxygen into the seed, diluting protoplasm and transporting food from endosperm or cotyledons to the growing points (Song ai et al, 2010). Water is indispensable for plants. If plants lack water, growth cannot take place properly (Trimayora et al, 2021). According to Karuwal et al. (2017), peat water is quite influential on legume germination. The physiological responses of plants to environmental stress are specific to each type of plant (Raharjeng et al. 2018).

From the results of the research conducted, it was found that all types of plants were able to germinate using peat water except soybeans (Figure 1). Germination rates varied. The highest percentage of germination was the type of *Vigna radiata* L, namely all seeds in germination successfully germinated (100%), while *Vigna unguiculata* L and *Phaseolus vulgaris* L had the same germination percentage of 80%. In the type of *Vigna radiata* L, the seeds began to germinate on the second day, while *Vigna unguiculata* L and *Phaseolus vulgaris* L began to germinate on the third day.

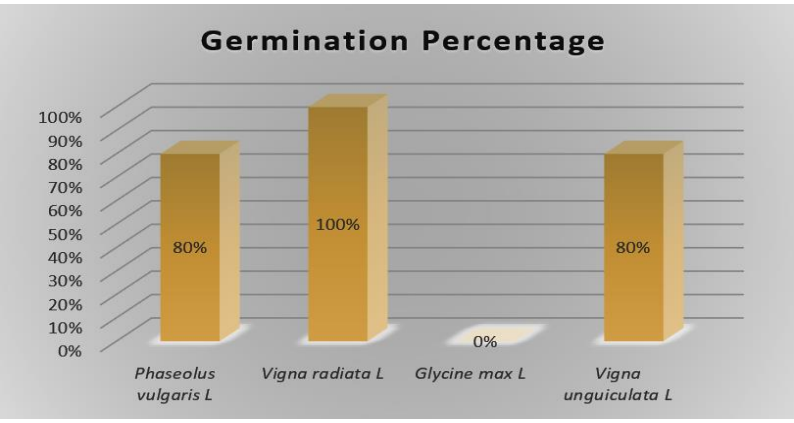

Figure 1. Germination percentage during 7 (seven) days of data collection

In line with the research conducted, according to Simanjuntak (2012), green plants generally begin to germinate on the second day, while beans and long beans begin to germinate on the third day. Soybeans generally start to germinate on the sixth or seventh day.

Not being able to grow *Glycine max* L on media filled with peat water may indicate that *Glycine max* L growth is stunted. However, further research is needed considering that germination is not only influenced by external factors, in this case, water, but also internal factors, one of which is seed quality. The results of research conducted by Ernawati (2012). Shows that seed storage time affects the germination rate of *Glycine max* L. Storage will affect the quality and physiological conditions of *Glycine max* L seeds (Rahmi, 2016). Seed is an important plant production facility in the plant production process and the quality of the seed used in a crop production business will determine the productivity and quality of crop yields. In line with this, the process of seed production and handling needs to be taken seriously to obtain seeds that meet predetermined quality criteria (Dinarto, 2010).

Sprout Length

Sprout length is an indicator used to measure plant growth (Mfeka et al, 2019). Based on the average length of sprouts, it was found that the growth of mung bean sprouts was better than other

types. The highest average length of green sprouts was on the seventh day, which was above 4.14 cm, while for long beans it was 2.32 cm, and, around 2.04 cm for peas (Figure 2).

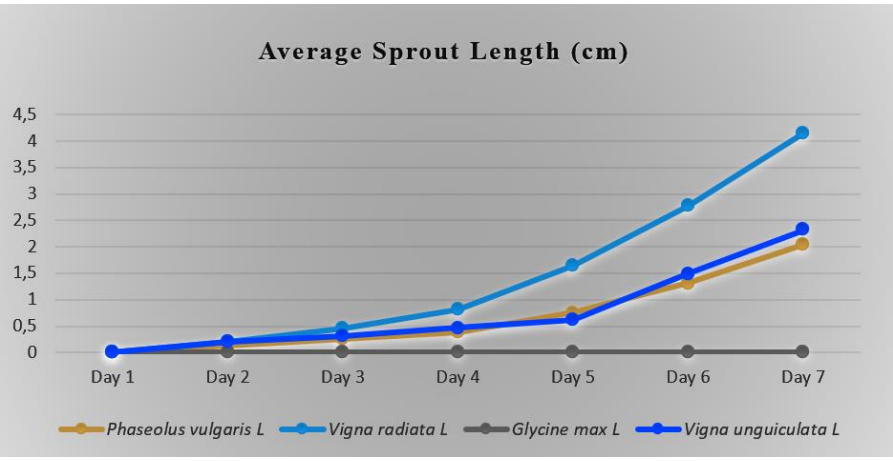

Figure 2. Sigmoid Curve of Sprout Growth for 7 (seven) days of data collection

Growth is a quantitative factor that is quite easy to observe, namely changes in number and size. One way to measure growth in legumes is to measure plant length (Ayudewi et al, 2020). Plant height is an easy-to-measure vegetative growth (Hastuti et al, 2018). Sprouts can grow well if growth factors, such as light, temperature, water, nutrients, and hormones are available optimally (Sudjadi 2006). In addition, growth is also influenced by genetic factors (Nur et al, 2018).

The results of the statistical analysis using the One Way ANOVA test showed that there was no significant difference between the growth of the three types of plants where the significance value was 0.069 (> 0.05), but there were significant differences between the three types of plants that grew when compared to soybeans that were not able to grow with a significance value of 0.01.

The number of Leaves Formed

The number of leaves is an indicator of growth (Ayalew et al, 2022). Based on the number of perfectly formed leaves, the number of leaves in *Vigna radiata* L and *Vigna unguiculata* L leaves were completely formed on the fourth day, while in *Phaseolus vulgaris* L it began to form from the fifth day (Figure 3). The number of leaves formed at the end of the study for green beans was 6 (six) leaves while for long beans there were 4 (four) leaves and for beans the number of leaves formed until the seventh day was 2 (two) leaves.

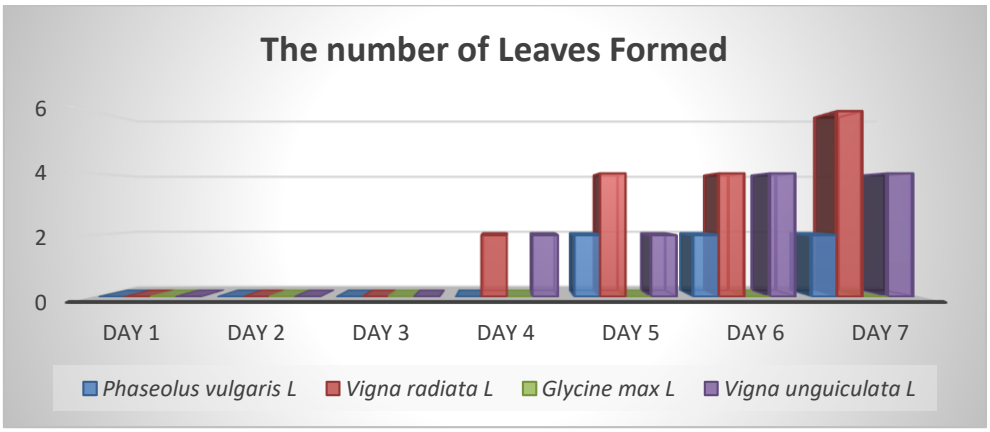

Figure 3. Number of leaves formed during 7 (seven) days of data collection

Plant growth is used as an indicator to determine plant characteristics and their relationship with environmental factors. The results showed that the environmental conditions in the form of

the concentration of flooding significantly affected the growth parameters, including leaves and roots. Plants can experience stress and stunted growth. Leaf area, fresh weight, dry weight, and root length decreased significantly with increasing stress levels. The most significant decrease occurred in the inundation stress treatment with an inundation concentration of 200% (Rohmah et al, 2016).

Water is a crucial factor for plant growth (Sousa et al, 2022). Absorption of water is the initial stage of the germination of seed. Water plays an important role in activating embryonic cells in seeds (Song Ai, 2010). Based on research by Hartiwi et al (2017), water has a significant effect on the growth of legumes, especially greens. Water is a factor that affects the productivity and quality of green beans. Mung bean plants have a critical period, namely at the time of germination. According to Haryati (2008), a lack of water can affect the vegetative growth of plants so these plants experience continuous water deficiency until they die. The response of plants experiencing drought stress affects their metabolic activity, cell volume becomes smaller, decreases leaf area, decreases the photosynthetic rate, and changes in carbon and nitrogen metabolism (Sinaga, 2008). Water is one of the most important physical components and is required in large quantities for plant growth and development. Approximately 85-90% of the fresh weight of cells and tissues of higher plants is. Water functions as a nutrient solvent, a constituent of protoplasm, a raw material for photosynthesis, and so on. Lack of water in plant tissues can reduce cell turgor, increase the concentration of macromolecules and affect cell membranes and the potential for the chemical activity of water in plants (Mubiyanto, 1997). Given the importance of the role of water, for plants that experience water shortages, it can result in the disruption of plant metabolic processes which ultimately affects the rate of plant growth and development (Anggrahini, 2007).

Based on the research results, it was found that peat water with an acidic pH did not significantly affect the performance of amylase in legumes except for soybeans. The types of legumes used such as *Vigna radiata* L, *Vigna unguiculata* L, and *Phaseolus vulgaris* L, can use peat water as a growth medium. Besides having an acidic pH, peat water has a high organic content. Peat water is surface water that is often found in peatland areas or lowlands, especially on the islands of Kalimantan and Sumatra. Peat water is dark brown to black in color, has a high organic content (138 - 1560 mg/lt), and is acidic (pH 3.7 - 5.3). The brownish-red color in peat water is the result of the high content of dissolved organic matter (humus material), especially in the form of humus acid and its derivatives. The characteristics of peat water besides having a low pH also has high levels of iron and manganese, and low hardness (Herlambang and Said, 2005: Wibowo and Suyatno 1998). According to Setiadi (2012) soil pH < 4 is a problem soil because there is an increase in Al and Fe elements, as well as a decrease in P elements. This condition causes the solubility of Al, Fe, and Mn elements to reach toxic limits in plants.

Conclusions

From the results of the study, it was found that 3 (three) types of Leguminous plants, namely green beans, long beans, and chickpeas were able to grow using peat water media, while soybeans could not germinate. Of the three types of plants, mung beans have a better growth rate than long beans and chickpeas. The highest average length of green sprouts is on the seventh day, above 4.14 cm, while in long beans it is 2.32 cm and peas are around 2.04 cm. Statistical analysis using the One Way ANOVA test showed there was no significant difference between the growth of the three types of plants where the significance value was 0.069 (>0.05), but there was a significant difference between the three types of plants that grew when compared to soybeans that were unable to grow with a significance value of 0.01.

References

Adesoye A.I, Togun A.O, Machuka J. (2010). Transformation of cowpea (*Vigna unguiculata* L. Walp.) by Agrobacterium infiltration. *Journal of Applied Biosciences*, 30(2010), 1845-1860.

Ayalew, T., T. Y. P. Hogy & G. Cadisch. (2022). Leaf growth, gas exchange and assimilation performance of cowpea varieties in response to *Bradyrhizobium* inoculation. *Journal Heliyon*. 8(2022), 1-8.

Ayudewi, F.M, A. Yudhana & R. Umar. (2020). Monitoring Pertumbuhan Kecambah Kacang Hijau Menggunakan Region Growing. *Jurnal Repositor*, 2(9), 1175-1182.

Dinarto, W. (2010). Pengaruh kadar air dan wadah simpan terhadap viabilitas benih kacang hijau dan populasi hama kumbang bubuk kacang hijau *Callosobruchus chinensis* L. *Jurnal AgriSains*, 1 (1), 68-78.

Dwidjosoeputro. (1978). *Dasar-dasar Mikrobiologi*. Jakarta : Djambatan.

Fatiqin A, Lestari D, Apriani I, Irohmi M, Sunarti R N, Suroto, Windri, Irawan Y. (2019). Uji Mutu Fisik Dan Fisiologi Benih Flamboyan (Delonix regia), Mangium (*Acacia mangium* Wild.), Sengon (*Falcataria moluccana*), Krasi (*Acacia crassicarpa*) Di Balai Perbenihan Tanaman Hutan (BPTH) Wilayah I. Prosiding Seminar Nasional Sains dan Teknologi Terapan**.** 2*(1)*

Felania, C. (2017). Pengaruh ketersediaan air terhadap pertumbuhan kacang hijau (Phaceolus radiatus). *Prosiding Seminar Nasional Pendidikan Biologi dan Biologi Jurusan Pendidikan Biologi, Fakultas MIPA, Universitas Negeri Yogyakarta*. (2017), 131-138.

Frank, T. E. (2013). *Floral Composition and Regeneration in the Sabangau Peat Swamp Forest*. (Thesis Julius Maximilians Universität Würzburg : Würzburg).

Hartiwi, Y.W., G. Wijana & R. Dwiyani. (2017). Growth and Yield of Various Mung Bean Varieties (*Vigna radiata* (L.) Wickzek in Different Water Content. *Journal Agrotrop*, 7 (2), 117-129.

Hastuti, D.P Supriyono & S. Hartati. (2018). Mungbean Growth and Yield on Different Organic Fertilizer Dosage and Planting Density. *Journal of Sustainable Agriculture*, 33(2), 89-95.

Junaidi dan F. Ahmad. 2021. Pengaruh suhu perendaman terhadap pertumbuhan vigor biji kopi lampung (*Coffeacanephora*). *Jurnal Inovasi Penelitian*, 2(7), 1911-1916.

Jacob, D. (2016). *Growth and yield of cowpea (Vigna unguiculata) following nitrogen fertilizer application and inoculation*. (Thesis Kwame nkrumah university of science and technology, kumasi, Ghana : Ghana).

Karuwal, R.L., Suharsono, A Tjahjoleksono & N. Hanif. (2017). Physiological responses of some local cowpea from Southwest Maluku (Indonesia) varieties to drought stress. *Journal Biodiversitas*. 18(4), 1294-1299.

Lestari, D., W. Lestariana, L. A. Lestari & A. Farmawati. (2019). The role of mung bean sprouts (*Phaseolus radiatus* (L.)) on retroperitoneal fat cells of Sprague Dawley rats fed high-fat diet. *Jurnal Gizi Klinik Indonesia*, 16(1), 31-39.

Mfeka, N., Reckson A. Mulidzi & Francis B Lewu. (2019). Growth and yield parameters of three cowpea (*Vigna unguiculata* L. Walp) lines as affected by planting date and zinc application rate. *Journal Department of Agriculture Cape Peninsula University of Technology, Cape Town, South Africa*, 115(1), 1-8.

Nugraheni, F.T S. Haryanti & E. Prihastanti. (2018). Influence of Depth of Planting Difference and Water Volume Against Germination and Growth of Shorgum Seed (*Sorghum Bicolor* (L.) Moench). *Jurnal Anatomi dan Fisiologi*. 3 (2), 223-232.

Nur, F., Baiq F. Wahidah & E. Afdal. (2018). Pertumbuhan berbagai macam varietas tanaman kacang hijau (*Phaseolus radiatus*) pada tanah ultisol. *Jurnal Teknosains*, 12 (2), 229-240.

Nurhafidah, Abdul R. Abbas K, Hasyim H. & Juraeje. (2021). Seed germination test of corn (*Zea mays*) varieties using different methods. *Journal Agroplantae*, 10 (1), 30-39.

Ntombela, Z. 2012. *Growth and yield responses of cowpeas (Vigna unguiculata L.) To water stress and defoliation*. (Dissertation College of Agriculture, Engineering and Science University of KwaZulu-Natal Pietermaritzburg South Africa: KwaZulu-Natal Pietermaritzburg).

Pratiwi, D., D. Sawitri K. and Aulya N. P. (2018). The diversity of legume in jember regency. *Jurnal Biologi dan Pembelajaran Biologi*, 3*(2),* 113-123.

Raharjeng, A. R. P., Fatiqin, A., & Sunarti, R. N. 2018. Sistem tanam hidroponik sayur bayam merah (*Amaranthus gangeticus*) dengan menggunakan limbah cair tahu sebagai nutrisi pertumbuhan. Jurnal Biosilampari: Jurnal Biologi 1*(1)*: 1-9.

Rahmi, S. (2016). Shelf-life Soybean of Seed Estimation Using Accelerated Shelf-life Testing (ASLT) Method. *Jurnal Keteknikan Pertanian*. 4 (1), 75-80.

Rajab, M.A. (2016). Pengaruh pertumbuhan kacang hijau (*Phaseolus radiatus*) dengan perlakuan pemberian media air berbeda. *Jurnal Penelitian Universitas Cokroaminoto Palopo*. 1(2016), 1-10.

Ramdhani, W.P. Mahmud, dan P. Soewondo. (2009).Level of aluminum (al) and iron (fe) in liquid coagulant production process from clay of peat land. *Jurnal Teknik Lingkungan*, 15(1), 37-45.

Rohmah, E.A & Triono B.S. 2016. Analisis Pertumbuhan Tanaman Kedelai (*Glycine max* L.) Varietas Grobogan Pada Kondisi Cekaman Genangan. *Jurnal sains dan seni ITS*, 5(2), 2337-3520.

Setiadi, Y & Fiona C.A. (2015). Early Detection of Aluminum Toxicity on *Bridelia monoica* Merr. to Post Coal Mined Land in PT. Jorong Barutama Greston, South Kalimantan. *Journal Silvikultur Tropika*, 6 (2), 101-106.

Simanjutak, F.A., I Wayan Tika & Sumiyati. (2012). Pengaruh tingkat pemberian kompos terhadap kebutuhan air tanaman beberapa jenis kacang. *Jurnal Teknik Pertanian Fakultas Teknologi Pertanian Universitas Udayana*, 1(3), 1-10

Song Ai, N and M. Ballo. (2010). Peran Air dalam Perkecambahan Biji. *Jurnal Ilmiah Sains FMIPA Universitas Sam Ratulangi Manado*, 10 (2), 190-195.

Sousa, DPP, Hildo G G C N, & Denilson P. 2022. Performance of Cowpea under Different Water Regimes in Amazonian Conditions. Jurnal Horticulturae. 8 (335), 1-12.

Sudjadi. B. (2006). *Biologi dan sains*. Jakarta : Yudistira.

Sutapa, I.D.A. (2014). Comparison of Poly Aluminium Chloride (PAC) and Aluminium Sulphate Coagulants Efficiency in Reducing Peat Water Turbidity Obtained from Katingan District Central Kalimantan Province. *Journal Ris.Geo.Tam* , 24(1), 13-21.

Trimayora, L & S. Fuadiyah. (2021). Pengaruh Air Terhadap Pertumbuhan Kacang Hijau (*Phaceolus radiatus*). *Prosiding Seminar Nasional Biologi 2021 Universitas Negeri Padang*, 1(2021), 193-197.