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VEGETATIVE GROWTH OF CASSAVA (*Manihot esculenta* Crantz.) ON THE LIQUID ORGANIC FERTILIZER OF LEGUMINOSAE SPECIES AND CONCENTRATION

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ABSTRACT

Cassava is one of the food crops with continous increasing demand. This study aimed to investigate the response of vegetative cassava growth to the application of different concentrations and types of liquid organic fertilizers (LOF) from *Leguminosae* plants. The research was conducted from February 27 to June 27, 2022, in Kembanglimus Village, Borobudur District, and arranged factorially (4x3) using a Randomized Completely Block (RCB). The first factor was the type of liquid organic fertilizer derived from *Leucaena leucocephala*, *Mimosa pudica*, and *Arachis hypogaea*. The second factor was the concentration of LOF, consisting of 0 mL/L, 15 mL/L, 30 mL/L, and 45 mL/L. Chlorophyll content was analyzed using spectrophotometer and protein contet of leaf and tuber were analyzed with Kjeldahl methods. The results demonstrated that type of LOI_ did not have a significant effect on all parameters. Liquid organic fertilizer from *Leguminosae* plants with 0 mL/L concentration resulted in the highest number of roots. Type of liquid organic fertilizer from *Leucaena* leaf with a concentration of 24.95 mL/L gave the highest number of roots, while type of LOF of *Mimosa pudica* with a concentration of 26.31 mL/L gave the highest number of branches. Type of liquid organic fertilizer of *Arachis hypogaea* with a concentration of 45 mL/L resulted in the highest total chlorophyll content, leaf protein content, and protein content in the tubers.

Keyword: *Arachis hypogaea, Leguminosae*, *Leucaena* leaf, *Mimosa pudica*, protein

ABSTRAK

[PERTUMBUHAN VEGETATIF UBI KAYU (*Manihot esculenta* Crantz) PADA PUPUK ORGANIK CAIR SPESIES LEGUMINOSAE DAN KONSENTRASI]. Ubi kayu merupakan salah satu tanaman pangan yang permintaannya terus meningkat. Penelitian ini bertujuan untuk mempelajari respon pemberian jenis pupuk organik cair (POC) tanaman *Leguminosae* dan konsentrasinya terhadap pertumbuhan vegetatif ubi kayu. Penelitian dilakukan mulai 27 Februari sampai 27 Juni 2022 di Desa Kembanglimus, Kecamatan Borobudur yang disusun secara faktorial (4x3) menggunakan Rancangan Acak Kelompok Lengkap (RAKL). Faktor pertama adalah jenis pupuk organik cair (POC), terdiri atas daun lamtoro, putri malu dan jerami kacang tanah. Faktor kedua adalah konsentrasi POC yang terdiri atas 0 mL/L, 15 mL/L, 30 mL/L, dan 45 mL/L. Kandungan klorofil dianalisa dengan spektrofotometer dan kandungan protein daun dan umbi dianalisa menggunakan metode *Kjeldahl*. Hasil penelitian menunjukkan bahwa jenis POC berbeda tidak nyata pada semua peubah. Konsentrasi 0 mL/L POC dari tanaman *Leguminosae* memberikan hasil tertinggi pada jumlah akar. Jenis POC dari daun lamtoro dengan konsentrasi 24,95 mL/L memberikan hasil tertinggi pada jumlah akar. Jenis POC dari putri malu dengan konsentrasi 26,31 mL/L menghasilkan jumlah cabang tertinggi. POC dari jerami kacang tanah dengan konsentrasi 45 mL/L memberikan hasil tertinggi pada jumlah total klorofil dan kandungan protein daun, serta protein pada umbi.

Kata kunci: daun lamtoro, kacang tanah, *Leguminosae*, protein, putri malu

INTRODUCTION

Cassava (*M. esculenta*) is extensively cultivated as an annual crop in tropical and subtropical regions (El-Sharkawy, 2006). Cassava is a food crop with high carbohydrate content in its tubers and is the most important food crop after rice and corn. Cassava is considered a staple root crop for more than 800 million people living in developing tropical countries (Burns *et al*., 2003). About 70% of world cassava root production is used for human consumption either directly after cooking or in processed forms. Another 30% is used for animal feed and other industrial products, such as starch, glucose and alcohol (El-Sharkawy 2004).

Food and Agriculture Organization (FAO) noted that the production of cassava in Indonesia has been steadily increasing from an average of 24 million tonnes in 2010 to an average of 27 million tonnes in 2020. In 2021, Indonesia produced 28 million tonnes of cassava, making it the world's third largest producer of this crop (FAO, 2022). Based on data of the Central Agency of Statistics or Badan Pusat Statistik (2018), cassava productivity in Central Java reached 232.66 kw/ha in 2018. Demand for cassava has increased from year to year, both for consumption and as a raw material for various industries (Ariningsih, 2016).

Efforts to increase growth of cassava crop are required to increase productivity. Simultaneously, air pollution is a serious problem because of the continuous population increase. More pollution is caused by vehicles and industrial sector contributes to increase CO_2 levels in the air. Ismayati *et al*., (2014) in Izzah *et al*., (2019) stated that air pollution in Indonesia is contributed by motor vehicle exhaust gases by 60-70% and by industry by 10-15%. In 2017, the concentration of CO2 in the atmosphere was 405.6 ppm and continued to increase, followed by an increase in earth temperature (Kurnia, 2020). Carbon dioxide (CO_2) is one of the materials used by plants to carry out photosynthesis. The photosynthesis process is carried out in leaf chlorophyll. The more chlorophyll in the leaves, the more maximal the photosynthesis process will be and the higher the CO_2 levels needed by the plant. Pandey *and* Sinha (1979) in Pratama & Laily (2015) stated that low chlorophyll levels mean that photosynthesis reactions cannot be maximized.

One of the components of leaf chlorophyll is the elements Mg and N, both in chlorophyll a and chlorophyll b. In line with Wenno (2019) main components making up chlorophyll are N and Mg. The addition of Mg and N elements is expected to be an effort to increase leaf chlorophyll. Legume chlorophyll are N and Mg. The addition of Mg and N elements is expected to be an effort to increase leaf chlorophyll. Legume plants can be an alternative because these plants can fix nitrogen in the air in symbiosis with several bacteria. There are various kinds of plants from *Leguminosae* family that might be used as additional source of nitrogen, included *Leucaena* or river tamarind, peanuts, and *Mimosa* or sensitive plant.

The use of *Leguminosae* plants in LOF to increase N element is beneficial for the growth of cassava plants. For example, K element plays a role in the growth of tubers in cassava. Jeksen & Mutiara (2017) in Hidayat & Suharyana (2019) showed that liquid organic fertilizer coming from *Leucaena* contained N-Total 0.068%, P 0.029%, K 0.158%, Mg 0.018%. This study was aimed to determine the response of vegetative cassava growth to the application of different concentrations and types of liquid organic fertilizers from legume plant species.

MATERIALS AND METHODS

The research was carried out from 27 February 2022 to 27 June 2022 in Kembanglimus Village, Borobudur District, Magelang Regency. The materials used in the research were cassava stem cuttings, *Leucaena* leaf, *Mimosa*, peanut straw, water, effective microorganism (EM4), molasses, and chicken manure. LOFs were made by using 5 kg of each raw material to be chopped and then put into a composter. 200 mL of molasses was added to solution with 200 mL of EM4 and 4 L of water, and then they were mixed to the composter for each raw material. All ingredients are mixed in the composter then closed tightly. The lid of the composter has a hose connected to a bottle filled with water to drain CO_2 during fermentation. The composter was stored in a shady place and the liquid organic fertilizer was filtered after 2 weeks.

Cassava leaf chlorophyll was analysed using a spectrophotometer with wavelengths of 645 nm and 663 nm. Test the protein content in the leaves of cassava plants used the Kjeldahl method. Protein content is calculated by multiplying the nitrogen content and the conversion factor (total nitrogen x 6.25). Due to a limited number of samples, protein analysis data were described qualitatively.

The research was arranged factorially with a Complete Randomized Block Design (CRBD). The first factor was concentration, namely 0 mL/L, 15 mL/L, 30 mL/L, and 45 mL/L. The second factor was the type of liquid organic fertilizer of Leguminosae plants, namely *Leucaena* leaf, *Mimosa* and peanut straw. Treatments was repeated three times. Data were analysed using Analysis of Variance (ANOVA). Means were separated by orthogonal polynomial for concentration and least significant different (LSD) 5 % for liquid organic fertilizer.

Cassava was planted in plots of 150 cm x 150 cm, with 16 cassava cuttings with a spacing of 40 cm x 40 cm per plot. Each LOF corresponded with the treatment concentration (0 mL/L, 15 mL/L, 30 mL/L, and 45 mL/L) was applied every two weeks. The application began at 14 days after planting.

RESULTS AND DISCUSSION

The results of variance analysis showed that the liquid organic fertilizer concentration and type of *Leguminosae* plants influenced root number and number of branch with F-value of 6.05 and 3.15, consecutively (it were not shown in the F-calculation table). The orthogonal polynomial analysis was demonstrated at the following Figure 1.

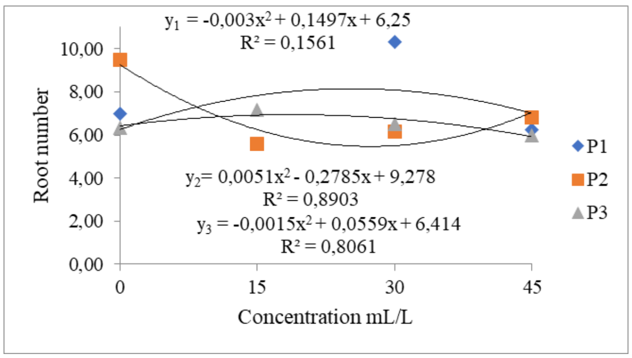

Figure 1. Concentration and liquid organic fertilizer of *Leguminosae* plant species on root number

The optimum concentration of LOF of 24.95 mL/L and *Leucaena* leaf (P_1) resulted in number of roots of 8.11. This was as a result of the increase of the availability of nutrients, nitrogen, and potassium in the soil. These nutrients are used by plants for root growth. Nitrogen is a macro-element that is necessary for plants to grow. This element functions as a basic ingredient for amino acids to stimulate plant cell division (Nadzifah *et al*., 2020). According to Sarwono (1995) *In* Shanti & Nirmala (2018), the K element has the function of increasing resistance to drought and root development. In addition, roots have important functions such as absorbing water and nutrients (Erktan *et al*., 2018 *In* Ginting, 2020). According to Alwi *et al*., (2022) plant roots that grow easily cause more nutrient and water absorption.

Liquid organic fertilizer can increase the number of roots in plants. The study found that the application of LOF resulted in a significant increase in the number of primary roots, lateral roots, and total root length. The increase in root number is due to the increased availability of nutrients in the soil. LOF also helped to improve the soil structure and water retention capacity, which also contributed to the increase in root number (Jones, 2012).

Concentration of LOF and legume plant species differed significantly on the number of branch (Figure 2).

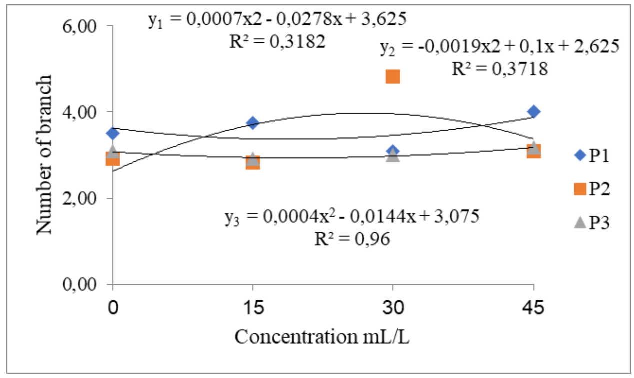

Figure 2 indicated that the optimum LOF concentrations for legume plant spesies was 26.31 mL/L for *Mimosa* (P_2) with the number of branches 3.94. There is a positive correlation between LOF application and branch number in cassava. LOF can significantly increase the number of branches in cassava plants, leading to higher yields. The increased branching is primarily attributed to the enhanced nutrient availability and improved soil conditions brought about by LOF application. Gutierrez *et al*. (1988) stated that the development and growth of cassava was affected by weather, soil water and nitrogen.

This is because nutrient content at this concentration was 0.12 %. Susi *et al*., (2018) explained that nitrogen stimulates overall plant growth covering vegetative growth. According to Efendi *et al*., (2017) nitrogen plays a role in stimulating the growth of stems and branches. Adequate nitrogen levels promote vegetative growth, including the development of leaves, stems, and branches. It is particularly important for the early growth stages of plants and can influence overall plant size. Nitrogen helps improve a plant's ability to withstand environmental stresses, such as drought and disease. It plays a role in the synthesis of compounds that help plants adapt to challenging conditions.

New leaves are produced over time with the number of leaves for each cohort related to the branching pattern. The overall phenology is through branching, which defines the potential leaf production rate and architecture of the plant. First branching is predicted when the available carbohydrates (photosynthesis plus reserves) are three times greater than the demand, while additional branching is based on thermal time. The potential demand for assimilate and nitrogen is a function of the leaf production rate based on growth stage. The growth of stems, feeder roots, and storage roots are proportional to the leaf demand. The potential demand for assimilate is compared to the total assimilates and reserves that are available for growth to determine the overall growth of the plant. The increase in leaf area and the actual growth of all organs is reduced proportionally if the assimilate is less than the demand (Moreno-Cadena *et al.*, 2021). Total chlorophyll content in cassava plant leaves was presented in Table 1.

Table 1. Chlorophyll content and protein content of leaf

Treatment	Total chlorophyll	Leaf protein (%)
K_0P_1	77.08	1.54
K_1P_1	71.80	2.29
K_2P_1	71.93	3.58
K_3P_1	77.47	4.12
K_0P_2	71.98	1.59
K_1P_2	72.40	2.38
K_2P_2	72.77	3.26
K_3P_2	77.51	4.48
K_0P_3	75.95	1.53
K_1P_3	77.23	2.02
K_2P_3	76.97	3.57
K_3P_3	**78.06**	4.59

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Table 1 illustrates that the highest total chlorophyll content was 78.06 mg/L, found in the K3P3 treatment combination liquid organic fertilizer of peanut straw with a concentration of 45 mL/L. LOF from peanut straw containing 0.42% sulfur can be optimally absorbed by plants to synthesize chlorophyll. Wati *et al.,* (2014) stated sulfur plays a role in plant growth, forming chlorophyll and constructing proteins. Plant with deficiency of sulfur, growth is inhibited and leaves turn to yellow and are stunted.

Concentrations of nutrients in the cassava leaves varied with the growth stage, but within a narrow range throughout the season (Howeler, 2012). Salamah *et al*., (2022) mentioned leaves function to carry out photosynthesis and produce glucose. Leaves absorb sunlight to synthesize chlorophyll. Chlorophyll is a pigment in the plant functioning to convert light energy into chemical energy. Pigments and molecules in the photosynthesis process take energy from sunlight to form ATP and NADPH coenzymes which are then used in the stroma to form carbohydrates from carbon dioxide and water. Chlorophyll is found in chloroplasts which is the cause of the green colour of leaves (Dharmadewi, 2020).

The chlorophyll content in dark green leaves is 50% higher than in light green leaves. This can happen because dark green leaves have a dominant chlorophyll content than light green leaves. All green plants contain chlorophyll a and b. Chlorophyll a and b are the main pigments in the thylakoid membrane. Chlorophyll a makes up 75% of the total chlorophyll (Solikhah *et al*., 2019). Results showed that varied fertilizer rates and caused in changes or modifications of cassava physiology, including chlotophyll content. N was mostly partitioned to the leaves. The partitioning to leaves and stem for N significantly increased. Adiele *et al*., (2020) mentioned that the relative nutrient uptake and allocation to plant parts varied over time but was similar for fertilized and unfertilized plants although the fertilized plants absorbed nutrients in much greater quantities. Differences in concentration of LOF and type of legume plant species affected cassava growth. There is a difference in leaf protein content (Table 1).

LOF with a concentration of 45 mL/L each with peanut straw (K_3P_3), *Mimosa* (K_3P_2), and Leucaena (K_3P_1) respectively produced leaf protein with a concentration of 4.59, 4.48, and 4.12 percent. LOF made from legume plant species can contribute N content. Legume residues can be relatively high in nitrogen because of the nitrogen-fixing abilities of legume plants and their nitrogen-rich nodules. Nitrogen from the legume residues, as well as other compost materials, can become available to cassava plants when the finished compost is applied to the soil.

LOF from legume plant can improve the nutrient content of cassava-growing area. This fertilizer provides a slow-release source of nutrients, including nitrogen, to cassava plants as they grow. The primary factor affecting the protein content in cassava leaves is the genetic makeup of the cassava variety being grown and its nutrient uptake capacity. However, using compost, especially if it contains legume plant residues, can provide a sustainable and organic way to improve overall soil fertility and support healthy cassava growth. Cassava, unlike many crops, markedly reduces its leaf area and maintains the leaf nutrient contents when the availability of nitrogen and phosphorous are limited (Cock & Connor, 2021).

CONCLUSION

Fertilization using liquid organic fertilizer from *Leguminosae* plants provides a response to the growth of cassava. The highest results were shown in the number of roots with a concentration of 24.95 mL/L from LOF of *Leucaena* leaf and the number of branches at a concentration of 26.31 mL/L from LOF of *Mimosa*. Concentration of 45 mL/L LOF of peanut straw showed the highest result for the total chlorophyll content and leaf protein content.

REFERENCES

Adiele, J.G., Antonius, G.T.S., Kodjovi, S.E., Pieter, P. & Ken, E.G. (2020). Dynamics of N-P-K demand and uptake in cassava. *Agronomy for*

Sustainable Development, 41(1), 1. DOI: https://doi.org/10.1007/s13593-020-00649-w

Alwi, I.A.S., Tusi, T., Oktafri & Warji. (2022). Pertumbuhan akar dan produktivitas tanaman tomat (Solanum lycopersicum L.) dengan variasi ukuran media tanam hydroton. *Jurnal Agricultural Biosystem Engineering*, 1(2), 152-161. DOI: http://dx.doi.org/10.23960/jurnal%20abe.v1i2.5980.

Ariningsih, E. (2016). Peningkatan produksi ubi kayu berbasis kawasan di Provinsi Jawa Barat dan Sulawesi Selatan. Analisis Kebijakan Pertanian, 14(2), 125-148.

Badan Pusat Statistik. (2018). Ubi Kayu 2015-2018. BPS Jawa Tengah. Semarang.

Burns, C.E., Johnston, K.M. & Schmitz, O.J. (2003). Global climate change and mammalian species diversity in US national parks. Proceedings of the National Academy Sciences USA, 100, 11474–11477. DOI: https://doi.org/10.1073/pnas.1635115100.

Cock, J.H. & Connor, D.J. (2021). Cassava. In: Sadras, V.O. & Calderini, D.F. (Eds.), Crop Physiology Case Histories for Major Crops. *Elsevier*, 588–633. DOI: https://doi.org/10.1016/B978-0-12-819194-1.00019-0.

Dharmadewi, I.M. (2020). Analisis kandungan klorofil pada beberapa jenis sayuran hijau sebagai alternatif bahan dasar food suplement. *Jurnal Emasains: Jurnal Edukasi Matematika dan Sains*, 9(2), 171-176.

Efendi, E., Purba, D.W. & Husna Nasution, N.U. (2017). Respon pemberian pupuk NPK mutiara dan bokashi jerami padi terhadap pertumbuhan dan produksi tanaman bawang merah (*Allium ascalonicum* L.). *Jurnal Penelitian Pertanian BERNAS*, 13(3), 20-29.

El-Sharkawy, M.A. (2004). Cassava biology and physiology. *Plant Molecular Biology*,56, 481–501. DOI: https://doi.org/10.1007/s11103-005-2270-7.

El-Sharkawy, M.A. (2006). International research on cassava photosynthesis, productivity, ecophysiology, and response to environmental stresses in the tropics. *Photosynthetica*, 44(4), 481–512. DOI; https://doi.org/10.1007/s11099-006-0063-0.

FAO. (2022). World Food and Agriculture – Statistical Yearbook 2022. Rome. DOI: https://doi.org/10.4060/cc2211en.

Ginting, E.N. (2020). Pentingnya bahan organik untuk meningkatkan efisiensi dan efektivitas pemupukan di perkebunan kelapa sawit. *Warta PPKS*, 25(3), 139-154.

Helmi & Basyah, B. (2019). Pengaruh pemberian unsur hara mikro boron terhadap pertumbuhan dan produksi bawang merah (*Allium cepa*, L.). *JAR*, 2(1), 1-6.

Hidayat, O. & Suharyana, A. (2019). Pengaruh dosis pupuk organik cair daun lamtoro terhadap pertumbuhan dan hasil tanaman pakcoy (*Brassica rapa* L.) Varietas Nauli-F1. *Jurnal Ilmiah Pertanian*, 7(2), 57-63. DOI: http://dx.doi.org/ 10.35138/paspalum.v7i2.118 .

Howeler, R.H. (2012). Dry matter accumulation and nutrient absorption and distribution during the growth cycle of cassava. *In*: Howeler (ed) The cassava handbook: a reference manual based on the Asian Regional Cassava Training Course, Centro Internacional de Agricultura Tropical (CIAT), 351–410.

Izzah, A.N., Nasrullah, N. & Sulistyantara, B. (2019). Efektivitas jalur hijau jalan dalam mengurangi polutan gas CO. *Jurnal Ilmu Pertanian Indonesia* (JIPI), 24(4), 337-342. DOI: https://doi.org/10.18343/jipi.24.4.337 .

Jones, J.B. (2012). Plant Nutrition and Soil Fertility Manual. Second Edition. CRC Press Taylor and Francis Group. Boca Raton, FL 33487-2742.

Moreno-Cadena, P., Hoogenboom, G., Cock, J.H., Ramirez-Villegas, J., Pypers, P., Kreye, C., Tariku, M., Ezui, K.S., Lopez-Lavalle, L.A.B., & Asseng, S. (2021). Modeling Growth, Development and Yield of Cassava: A Review. *Field Crops Research*, 267, 108140.

Nadzifah, U., Prihasanti, E. & Sumariyah, S. (2020). Pengaruh radiasi plasma lucutan pijar korona dan pupuk organik rumen sapi terhadap produksi bawang merah (*Allium ascalonicum* L.). *Jurnal Biologi Papua*, 12(1), 28-36.

Pratama, A.J., & Laily, A.N. (2015). Analisis kandungan klorofil gandasuli (Hedychium gardnerianum Shephard ex Ker-Gawl) pada tiga daerah perkembangan daun yang berbeda. Seminar Nasional Konservasi dan Pemanfaatan Sumber Daya Alam, 13 Januari, 216-219.

Salamah, D.M., Sulandjari, K. & Rahayu, Y.S. (2022). Pengaruh pemberian berbagai konsentrasi air kelapa muda terhadap pertumbuhan tunas stek batang ubi kayu (*Manihot esculenta* Crantz) pada Varietas Gajah dan Karet. *Agrovital: Jurnal Ilmu Pertanian*, 7(1), 49-54. DOI: http://dx.doi.org/10.35329/agrovital.v7i1.2125 .

Shanti, R., & Nirmala, R. (2018). Respon tiga varietas ubi kayu (*Manihot esculenta* L) terhadap pemupukan di Kutai Timur. *Jurnal Pertanian Terpadu*, 6(1), 46-58.

Solikhah, R., Purwantoyo, E. & Rudyatmi, E. (2019). Aktivitas antioksidan dan kadar klorofil kultivar singkong di daerah Wonosobo. *Life Science*, 8(1), 86-95. DOI: https://doi.org/10.15294/lifesci.v8i1.30001

Sudaryono, T. (2017). Respon tanaman bawang merah terhadap pemupukan Boron. *Jurnal Ilmu-Ilmu Pertanian "AGRIKA"*, 11(3), 161-169.

Wati, Y.T., Nurlaelih, E.E. & Santosa, M. (2014). Pengaruh aplikasi bourin pada pertumbuhan dan hasil tanaman bawang merah (*Allium ascalonicum* L.). *Jurnal Produksi Tanaman*, 2(8), 613-619.

Wenno, S.J. & Sinay, H. (2019). Kadar klorofil daun pakcoy (*Brassica chinensis* L.) setelah perlakuan pupuk kandang dan ampas tahu sebagai bahan ajar mata kuliah fisiologi tumbuhan. *Biopendix*, 5(2), 130-139. DOI: https://doi.org/10.30598/biopen dixvol 5issue2page130-139