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Leaf character of sugar palm on various shades and concentrations of liquid organic fertilizer

Abstract. Palm sugar has been developed to produce various products and raw materials for their derivatives. There is a very high morphological diversity of sugar palm plants (*Arenga pinnata* (Wurmb) Merr.), while the morphological identification of different sugar palm plant species in Banten province is still limited. The aim of this research is to determine the effect of different treatments, such as shade percentage, liquid organic fertilizer concentration, and a combination of both, on the properties of palm leaves. The experimental design used in this study was the 2-factor RCBD split plot with 3 levels each. The first factor is the variation of the shadow percentage, namely N0 (no shadow), N1 (55% shadow), and N2 (85% shadow). The second factor is different concentrations of liquid organic fertilizer (POC), namely P0 (0 ml/liter water), P1 (1 ml/liter water), and P2 (2 ml/liter water). The results showed that different types of shade yielded insignificant results in terms of variable number of leaves, total leaf area, and leaf greenness. The different types of liquid organic fertilizer concentration treatments and treatment combinations of shade percentage and liquid organic fertilizer concentrations did not influence any of the observed variables.

Keywords: Growth · Palm · Organic fertilizer · Shade

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Introduction

Sugar palm (*Arenga pinnata* Merr) is one of the important palm plants after coconut and oil palm. Almost all parts of this annual plant have economic value and can be utilized, so it has a high potential to be developed (Sebayang, 2016).

The main problem with sugar palm plants is that the intensive cultivation system has not been carried out. Sugar palms are usually allowed to grow naturally without advanced treatment, so the sap yield is still relatively low. Therefore, it is necessary to carry out various treatments for sugar palm plants that can increase production (Paulina et al., 2018; Rattan et al., 2022).

Shading can be one of the attempts to adjust the light intensity to the needs of the seedlings and is expected to have a positive effect on the growth of the seedlings. The sugar palm naturally grows in the shade of the canopy in the country, so the level of shade is one of the most important factors influencing the growth of the sugar palm. Research by Furqoni et al. (2018) shows that shady palm seeds have more optimal growth. 56% shade can increase the wet weight, dry weight, and root volume of sugar palm seedlings compared to seeds that receive no shade. According to Samal et al. (2020), the sugar palm plant is a semi-shade tolerant plant, which means that the sugar palm needs shade early in its growth. According to Barus (2017), young oil palm seedlings need shade to reduce the intensity of sunlight at the beginning of growth because too high or too low light intensity is one of the inhibiting factors for the growth of young oil palm seedlings. There is limited information on the optimal amount of shade for sugar palm farms, so it is necessary to conduct research. In addition to shading, the carrying capacity of the soil is an important factor in the cultivation phase. The low availability of nutrients in the soil for seedlings can be overcome by adding nutrients through organic fertilizers.

Liquid organic fertilizer is widely used to add nutrients to plants from organic waste processing (Roidah, 2013). The liquid organic fertilizer content used in this study includes 0.18% $N+P_2O_5+K_2O$ total, 4.6% C Organic, 41.04 ppm Zn, 8.43 ppm Cu, 2.42 ppm Mn, 2.54 ppm Co, 0.45 ppm Fe, 0.12% S, 60.40 ppm Ca, 16.88 ppm Mg, 0.29% CI, 0.15% Na, 60.84 ppm B, 0.01% Si, 6.38 ppm Al, 0.98% NaCI, 0.11 ppm Se, <0.06 ppm Cr, <0.2 ppm Mo, <0.04 ppm V, 0.35% So_4, pH 7.91, 0.44% lipid, 0.72% proteins, 0,01% humic, vulvic, gibberellin, cytokinin, auxin (Stockistnasa, 2022).

Leaves have a special function in photosynthesis and respiration with a flat shape, which makes it easy to receive sunlight and carbon dioxide and facilitate the process of water and water vapor flowing in and out. Morphologically, leaves have different shapes, colors, sizes, and textures. This is related to the task of these organs to carry out the basic physiological functions of plants. Conversely, leaves are structurally divided into the epidermis (with stomata), mesophyll, and transport tissue. However, the composition of these components is influenced by the physical environment, such as water availability, light intensity, and the ecological niches of the plants (Riyaldi et al., 2017).

The aims of this study were (1) to determine the effect of various shading on the characteristics of palm leaves, (2) to determine the effect of different liquid organic fertilizer concentrations on the characteristics of palm leaves, and (3) to know the effect of the combination of organic liquid fertilizer concentration and the best shade for the characteristics of palm leaves.

Materials and Methods

The research was conducted at the screen house of the Experimental Farm of the Faculty of Agriculture, Universitas Jenderal Soedirman, with an altitude of 110 meters above sea level. The study was carried out from September until December 2021. The experimental design used in this study was the Split Plot Randomized Block Design with 2 factors with 3 levels each. The first factor is the percentage of shade, namely N_0 (without shade), N_1 (55%), N_2 (85% shade). The second factor is the type of liquid organic fertilizer concentration, namely P_0 (without fertilizer), P_1 (1 mL liter^{-1}), P_2 (2 mL liter^{-1}).

Shade was applied at the beginning of the study with the respective percentages of 55% and 85% ± 2m from the top of the seedling and ±0.5m to the side of the seedling. The application of liquid organic fertilizer was carried out 8 times with doses according to treatment, as much for every plant once every 14 days by pouring it into polybags. Data collection for sugar palm plants was carried out when the plants were 20, 40, 60, and 80 days after transplanting.

Observed variables include:

1. Increasing the number of leaves (sheets)
   Fully opened leaves are counted. The increase in leaf number was measured at 40 and 80 days of age after transplanting and measured by the formula (Farida, 2017):
   The increase in the number of leaves = [the number of last leaves – the number of early leaves].
2. Total leaf area (cm^2)
   The total leaf area is calculated using the length per width method using the following formula:
   Leaf area = P×W×k,
   where LD = leaf area; P = leaf length; L = blade width; and k = (0.66) constant.
   The value of this constant is obtained by comparing the value between the actual leaf area (which was performed using the graph paper method in this study) and the estimated leaf area using the length x width value. After transplanting, the total leaf area was measured at 40 and 80 days of age (Susilo, 2015).
3. Stomata density (μm^2)
   Stomata density is a comparison of the number of stomata in the area (Marantika, 2021) and is measured at 40- and 80-days post-transplantation (HPST). Calculated with the formula:
   Stomata density = (number of stomata)/(field of view)
   The formula calculates the field of view: 1/4 x π x d2, π = 3.14, and d = diameter of the microscope's field of view = 0.45.
4. Green of Leaves (unit)
   Chlorophyll content was measured on the plant's top, middle, and bottom leaves using the Soil Plant Analysis Development (SPAD) tool. This measurement is made on the 2nd wing of the last fully opened wing. The increase in the number of leaves was measured at 40 and 80 days after transplanting.

The results of the observation of variables consisting of the increase in the number of leaves, total leaf area, stomata density, and green leaves were then analyzed for variance with the F test at the 5% level that had a significant effect. It was continued with the Duncan's Multiple Range Test (DMRT) tests at the significant level of 5% at the DSAASTAT application.

Results and Discussion

The analysis using the F test showed that the type of shade treatment only affected the increase in the number of leaves, the total leaf area, and the greenness of the leaves (Table 1).

Table 1. The average data on the effect of various percentages of shade and types of liquid organic fertilizer concentrations on the leaves of sugar palm seedlings (5 months old).

Treatments	INL (sheet)	TLA (cm^2)	SD (μm^2)	GL (unit)
Shade	7.142	5.183	3.170	9.375
F 0.5	5.143	5.143	5.143	5.143
Sig.	*	*	ns	*
Liquid organic fertilizer	2.689	1.023	0.289	2.514
F 0.5	3.555	3.555	3.555	3.555
Sig.	ns	ns	ns	ns
Shade X Liquid organic fertilizer	0.61	0.213	0.481	2.758
F 0.5	2.928	2.928	2.928	2.928
Sig.	ns	ns	ns	ns

Note: INL = increase of number leaves, TLA = total leaf area, SD = stomata density, GL = greenish leaves. The numbers listed are obtained from the results of the analysis of variance using the F test at the 5% level. Ns = not significantly different, * = significantly different at Duncan's test.

Increase the number of Leaves. The significant difference in the variable number of leaves in different types of percent tint treatment shows no significant difference in the treatment of different organic liquid fertilizer concentrations and their combinations (Table 1). Based on the results of further tests on the effect of shade types, the highest number of leaves was without shade, with 12.58 leaves, and the smallest number of leaves was found in the 55% shade, with 8.42 leaves (Figure 1).

The results showed that sugar palm seedlings with higher light intensity without shade had more leaves than sugar palm seedlings with 55% & 85% shade. The lower the light intensity, the fewer leaves (Akmalia & Suharyanto, 2017). Low light intensity will cause the ambient temperature to decrease and affect the primordial temperature, delaying the initiation of leaf formation. The number of leaves affected by shade has fewer leaves than plants that get full compared to those without shade light. The number of leaves affected by shade has fewer leaves than plants that get full light (without shade) (Handriawan et al., 2016; Wahba et al., 2016).

Balanced fertilization has a very positive effect on plant growth. The higher the concentration of liquid organic fertilizer used, the greater its contribution in providing the nutrients needed in plant physiological processes, but the balance of the availability of nutrients absorbed by plants will determine the increase in plant growth (Ramírez et al., 2010; Oktaviani et al., 2022).

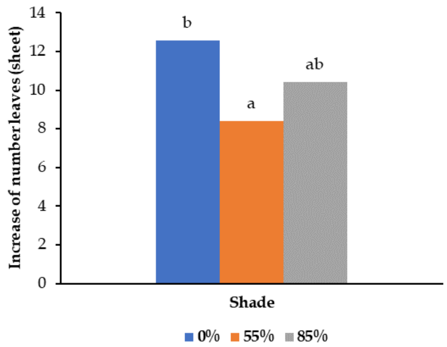

Figure 1. Bar chart of the increase in the number of sugar palm leaves.

Total Leaf Area. Various treatments of shade percentage to the total leaf area showed significantly different results. The F-count value is lower than the F-table, so H_0 is rejected. After further testing with the DMRT methods at the 5% level, there is no difference in letter notation (Figure 2).

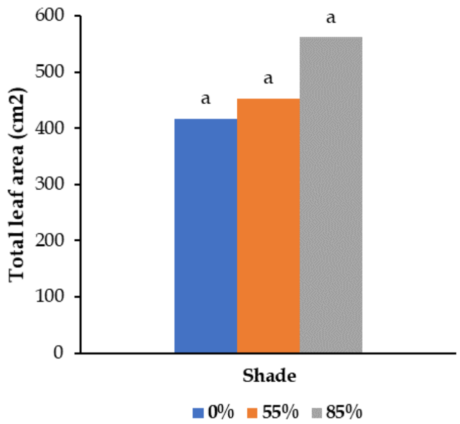

Figure 2. Bar chart of total leaf area on sugar palm plants.

Treatment of shade ratio to leaf area showed no difference between treatments. The percent shade with total leaf area values at 0.55% and 85% treatment was 416.56 cm^2; 418.50 cm^2 and 562.06 cm^2. This may be due to the influence of various existing environmental factors, such as the condition of the palm seeds in the greenhouse, which may have a different exposure to sunlight due to the location of the research greenhouse between other greenhouse buildings. In addition, changing environmental conditions, both in terms of temperature, humidity, and intensity of sunlight, can prevent the treatment from having a different effect. Apart from the fact that plants are generally capable of photosynthesis under optimal lighting conditions, the large increase in leaf area may also be due to plants adapting to the increase in light-trapping area, allowing photosynthesis to proceed normally even under shady conditions (Supriyono et al., 2017). An increase in leaf area in shaded plants is a mechanism of plant adaptation to shade stress (Xie et al., 2020; Ren et al., 2022). Extend these efforts to increase the light capture range for more efficient photosynthesis.

The treatment of liquid organic fertilizer concentration and its combination with shade had no significant effect on the total leaf area, one of which could be due to the incompatibility of the nutrient requirements of sugar palm seeds with the Liquid organic fertilizer concentration given. Several things must be considered in the application of liquid organic fertilizer, namely the type of liquid fertilizer used, the nutrient content, the concentration of the solution, and the time of application (Ren et al., 2022; Fernández-Delgado et al., 2022). Nutrient requirements in plants for growth and development are not the same, require different times, and not the same amount. Fertilization treatment should be given when plants need nutrients intensively for growth and development to take place properly.

Stomata Density. Variable stomata density, given various treatments such as percentage of shade, kinds of organic liquid fertilizer concentrations, and a combination of different percentages of shade and liquid organic fertilizer concentrations, showed results that were not significantly different in the analysis using the F test. The F-count value of each treatment is lower than the F-table (Table 1). This indicates a high value for each shading treatment for all variables.

These results showed that sugar palm seedlings treated without shade had higher light intensity and stomata density than palm seeds with shade (85%), which received lower light intensity. The number of leaf stomata in the treatment of high light intensity (without shade) was more than in the shade treatment, and shade reduced the density or distribution of stomata (Fitriatin et al., 2019). The absorption of nutrients that enter through the stomata will be different and have a very small effect on plant growth and yield if the time of spraying liquid fertilizer is different. It is not recommended to spray foliar fertilizer when the air temperature is hot because the concentration of the fertilizer solution that reaches the leaves quickly increases so that the leaves quickly increase so that the leaves can burn (Bergstrand, 2022)

Greenish Leaves. Various treatments of the percentage of shade on the greenness of the leaves gave significantly different results. Based on Table 1, which means the percentage of shade is significantly different. Further test results in Table 1. also show a significant difference according to the DMRT at the 5% level. The best type of shade treatment was 85% shade with a greenish value of 48.48 units.

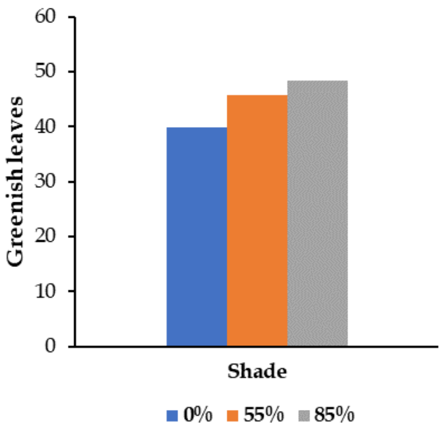

Figure 3. Bar chart of greenish leaves on sugar palm plants.

Based on the average results of greenery leaves on sugar palm seedlings, it can be concluded that the higher the percentage of shade, the denser the green color on the leaves. Shade treatment can affect chlorophyll content because the amount of light absorbed by plants is lower (Wulandari et al., 2016). To adapt to low light intensity, plants will increase light absorption by increasing the chlorophyll content per unit area of the leaf so that the green color of the leaves will be more concentrated (Sulistyowati et al., 2019).

Fluctuations in the liquid organic fertilizer concentration and the combination of different shade percentages and liquid organic fertilizer concentrations did not show a significant difference in the green of the leaves based on the results of the F test, as the calculated F value was smaller than the F -table. Conditions in the research environment can be affected by several factors, including temperature, humidity, light intensity, and precipitation. The light intensity distribution and the presence of precipitation may cause the light absorption of palm seeds to be different, so the shade treatment applied cannot tell the difference. Several factors determine the effectiveness of the use of liquid organic fertilizer, such as environmental factors, method of application, concentration, dosage, plant species, and the source of the organic matter used as a basis for producing liquid organic fertilizer, which also can fertilize. The treatment applied is no different (Haupt et al., 2021).

Conclusion

Treating different types of shadows yielded insignificant results for several variables, including total leaf area and chlorophyll, at both 0.55% and 85% shadows. Variations in liquid organic fertilizer concentration and combinations of different treatments in shade fraction and liquid organic fertilizer concentration also had no effect on any of the observed variables.

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Reference

Akmalia HA, Suharyanto E. 2017. The effect of different light intensity and water treatment to the growth of maize (*Zea mays* L.) "SWEET BOY-02". Sains Dasar, 6(1): 8–16.

Barus I, Astuti M, Hartati RM. 2017. Pengaruh modifikasi nutrisi dan naungan terhadap pertumbuhan bibit kelapa sawit pre nursery secara hidroponik. Jurnal Agromast, 2(1): 1-14.

Bergstrand KJ. 2022. Organic fertilizers in greenhouse production systems – a review. Sci. Hortic., 295. doi: 10.1016/j.scienta.2021.110855.

Fernández-Delgado M, del Amo-Mateos E, Lucas E, García-Cubero MT, Coca M. 2022. Liquid fertilizer production from organic waste by conventional and microwave-assisted extraction technologies: Techno-economic and environmental assessment. Science of the Total Environment, 806. doi: 10.1016/j.scitotenv.2021.150904.

Fitriatin BN, Silpanus R, Sofyan ET, Yuniarti A, and Turmuktini T. 2019. Effect of microbial fertilizers and dosage of NPK on growth and yield of Upland Rice (*Oryza sativa* L.). International Journal of Environment, Agriculture and Biotechnology 4(4): 899–902. doi: 10.22161/ijeab.442.

Furqoni H, Junaedi A, Wachjar A, Yamamoto Y. 2018. Growth responses of sugar palm (*Arenga pinnata* (Wurmb.) Merr seedlings to different shading levels. Trop.Agr.Develop., 62:(2) 55-59.

Handriawan A, Dyah WR, Tohari. 2016. Pengaruh intensitas naungan terhadap pertumbuhan dan hasil tiga kultivar kedelai (*Glycine max* (L.) Merill) di lahan pasir Pantai Bugel, Kulon Progo. Vegetalika, 5(3): 1–14.

Haupt R, Heinemann C, Schmid SM, Steinhoff-Wagner J. 2021. Survey on storage, application and incorporation practices for organic fertilizers in Germany. J Environ Manage, 296. doi: 10.1016/j.jenvman. 2021.113380.

Oktaviani A, Amalia L, Widodo RW. 2022. Pengaruh konsentrasi pupuk organik cair liquid organic terhadap pertumbuhan dan hasil tanaman kangkung darat (Ipomea reptans Poir.) sistem hidroponik rakit apung. Orchid Agro 2(1): 12–17. doi: 10.35138/ orchidagro.v2.i1.370.

Paulina M, Mansur I, Junaedi DA. 2018. Tanggap pertumbuhan aren (*Arenga pinnata* (Wurmb) Merr.) diinokulasi dengan fungi *Mikoriza arbuskula* dan pengapuran di lahan pasca tambang batubara Growth Responses of Sugar Palm (*Arenga pinnata* (Wurmb) Merr.) Inoculated with Arbuscular Mycorrhizal Fungi and Liming Application on the Coal Post-mining Land. Jurnal Silvikultur Tropika, 9(3): 196–204.

Ramírez F, Davenport TL, Fischer G. 2010. The number of leaves required for floral induction and translocation of the florigenic promoter in mango (*Mangifera indica* L.) in a tropical climate. Sci. Hortic., 123(4): 443–453. doi: https://doi.org/10.1016/j.scienta. 2009.10.005.

Rattan B, Dhobale KV, Saha A, Garg A, Sahoo L, et al. 2022. Influence of inorganic and organic fertilizers on the performance of water-absorbing polymer amended soils from the perspective of sustainable water use efficiency. Soil Tillage Res., 223: 105449. doi: https://doi.org/10.1016/j.still.2022. 105449.

Ren B, Yu W, Liu P, Zhao B, Zhang J. 2022. Responses of photosynthetic characteristics and leaf senescence in summer maize to simultaneous stresses of waterlogging and shading. Crop Journal. doi: 10.1016/ j.cj.2022.06.003.

Riyadi S, Irmayanti L, Rasyid J, Nur M. 2021. Eksplorasi Jenis dan Pemanfaatan Tumbuhan Obat Masyarakat Desa Indari Halmahera Selatan. J. Enviro Scienteae, 17(3): 39-46

Roidah SI. 2013. Manfaat penggunaan pupuk organik untuk kesuburan tanah. Jurnal Bonorowo, 1(1): 25-28.

Samal I, Mansur I, Junaedi A, Kirmi H. 2020. Evaluasi pertumbuhan aren (*Arenga pinnata* (Wurmb)) di lahan pasca tambang PT Berau Coal Kalimantan Timur. Media Konservasi, 25(2): 103–112. doi: 10.29244/medkon. 25.2.103-112.

Sebayang L. 2016. Keragaan eksisting tanaman aren (*Arenga pinnata* Merr) di Sumatera Utara (Peluang dan potensi pengembangan-nya). Pertanian Tropik, 3(2): 133–138.

Stockistnasa. 2022. "POC Nasa Pupuk Organik Cair" (*Online*). https://stockistnasa.com/ poc-nasa/ Accessed 5 January 2023.

Sulistyowati D, Chozin MA, Syukur M, Melati M, Guntoro D. 2019. Respon karakter morfo-fisiologi genotipe tomat senang naungan pada intensitas cahaya rendah. Jurnal Hortikultura, 29(1): 22. doi: 10.21082/jhort.v29n1.2019.p22-32.

Supriyono, Putri RBA, Wijayanti R. 2017. Analisis pertumbuhan garut (*Marantha arundinaceae*) pada beberapatingkat naungan. Agrosains 19(1): 22–27.

Wahba HE, Sarhan AZ, Salama AB, Sharaf-Eldin MA, Gad HM. 2016. Growth response and active constituents of *Cynara cardunculus* plants to the number of leaves harvests. European Journal of Agronomy, 73: 118–123. doi: https://doi.org/10.1016/j.eja. 2015.11.007.

Wulandari I, Haryanti S, Izzati M. 2016. Pengaruh naungan menggunakan paranet terhadap pertumbuhan serta kandungan klorofil dan β karoten pada kangkung darat (*Ipomoea reptans* Poir).

Xie F, Shi Z, Zhang G, Zhang C, Sun X, et al. 2020. Quantitative leaf anatomy and photophy-siology systems of C3 and C4 turfgrasses in response to shading. Sci Hortic., 274. doi: 10.1016/j.scienta.2020. 109674.