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Growth Effects of Corn Plants (Zea mays) on Agronomic Aspects of Oil Palm Tree Stands

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ABSTRACT

The study aimed to determine the agronomic study of the tolerance of corn plants to conditions shaded by oil palm trees. This research was conducted from July to October 2022. At the Oil Palm Plantation of the Community of Bunut Seberang Village, Asahan Regency, North Sumatra. This study used a factorial randomized block design with two factors and three replications. The first treatment consisted of a shading level (P) with 4 treatment levels namely (P0) without shading, (P1) 35% shading, (P2) 70% shading. The second treatment consisted of a variety of corn (J) with 6 varieties, namely Exsotic Pertiwi (V1), Paragon (V2), Bonanza F1 (V3), Bisi 2 (V4) varieties. The best plant height parameter in the shade level treatment showed 35% shade (P1) resulted in the highest plant height of 113.98 cm, while in the Variety (V4) Bisi-2 variety treatment showed the highest plant, namely 112.83 when compared to other varieties. The effect of various varieties on leaf area showed a significant effect at the age of 6 and 8 WAP. The degree of shade and differences in varieties show the similarity in the quality of the green leaves. The level of shade showed a significant effect on chlorophyll-a and total chlorophyll-a and b where the highest amount of chlorophyll-a was found in the treatment without shade, which was not significantly different from the level of 70% shade, while varieties had a significant effect in producing net photosynthesis formed

Keywords: *Corn Plants, Shaded. Palm oil*

PRELIMINARY

Corn (*Zea mays* L) is a commodity that has many benefits. In Indonesia, corn ranks second as the most important food crop after rice. Based on world food ingredients. Corn is the third most important after rice and wheat. Corn is very preferred because it can be consumed as a staple food or snack.

National corn production has increased. The data from the Ministry of Agriculture, (2020) confirms that the national demand for corn continues to increase, reaching 11.98 million tons per year or around 998 thousand tons/month, from January to December 2020 the national corn harvest area reaches 5.16 million hectares, while for the average the average corn production in Indonesia in 2019-2020 is 24.95 million tons. However, in 2020, the government decided to import 995.99 thousand tons of corn. This shows that the production of corn plants needs to be increased in accordance with the expectations of the nation. Thus it is necessary to expand the corn planting area in each city/district area that has potential.

The problem faced in Asahan Regency is that land for agriculture is increasingly limited due to the conversion of land to residential, industrial, road facilities and other physical facilities. which is relevant to the area of the plantation, limited initial capital for planting costs.

Salah satu peluang perluasan area tanaman Corn is in the land under the plantation crop canopy as an intercrop. The main problem of maize development among plantation crops is the low light intensity, while maize is a C4 crop which is sensitive to low light. The intensity of light received by corn plants, both intensity and quality, affects plant growth. Low light intensity

causes reduced photosynthesis, and reduced photosynthetic enzymes that function as catalysts in CO2 fixation. Selection of corn varieties that are tolerant to low shade is the right way to develop these plants in standing lands.

Intercropping cultivation of corn as an between plantation crops was carried out by farmers to increase the utilization of available land, especially for immature staple crops. Planting corn as an intercrop between coconuts yields 80% compared to monoculture corn plants (Mahdiannoor & Istiqomah, 2015). Utilization of land under stands of the perennial crops by means of a cropping system (polyculture) can be increase the efficiency of land use. Basically the application of cropping systems aims to increase efficiency and increase farmers' income. Polyculture is planting more than one type of plant on the same land at the same time.

One of the problems in increasing corn production in Indonesia is the lack of arable land. Not to mention the competition with land use for plantation crops, housing and even industrial areas. Increasing national production must take advantage of potential untapped land, including land under plantation and forestry plantations. Several studies in the last decade suggest that the monocropping system should be revised and may not be the best system anymore. taking into account sustainability, income security and nutritional diversity in rural areas. Therefore, intercropping systems offer an alternative to more sustainable farming with minimal inputs and stable yields (Gliessman, 2016).

The system of intercropping cropping patterns can increase corn production and affect the appearance and yield of plants, especially in the efficiency of using light intensity (shade). Corn is an annual crop. Its life cycle lasts from 80 to 150 days. The first cycle is the vegetative growth phase and the second cycle is the generative phase. The application of intercropping cropping patterns is more profitable because it will increase the function of the land, with more varied types of commodities produced, so that the risk of failure can be minimized (Rochmah et al., 2020).

Based on the description above, the authors are interested in conducting research on "The Effects of Growth of Corn Plants (Zea mays) on Agronomic Aspects of Oil Palm Tree Stands".

MATERIALS AND METHODS

Time and Place

This research was conducted from July - October 2022 at the Oil Palm Plantation of the Community of Bunut Seberang Village, Asahan Regency, North Sumatra

Materials and tools

The materials used in this study were six seeds of Pertiwi Exsotic Varieties (V1), Paragon (V2), Bonanza F1 (V3), Bisi 2 (V4), polybags, mixed soil media from top soil, sand, compost (volume ratio 3: 3:2), NPK compound fertilizer (15;15:15), Decis 25 EC insecticide, Dithane M-45 fungicide, Furadan 3G, Gramoxone 45 WP herbicide

The tools used in this study are Leaf Area Meter LICOR Li 3100 Area Meter to measure leaf area, Minolta Chorophyll meter SPAD-502 to measure the greenness of leaves, Spectrometer to measure the amount of chlorophyll-a and b, Lux meter (range 0-200,000 Lux and ±2% accuracy, to measure solar intensity, LI- 6200 XT (Portable Photosynthesis System) to measure leaf temperature (^oC) and net photosynthesis (µ mol m-2 s -1). Other tools used in this experiment included tillers (hoes, shovels and hammers), pruning shears, plastic hoses (water hoses), handsprayer, raffia rope, lat boards, digital cameras, 4mm sieve and laboratory equipment. such as ovens and for histological investigations such as microtomes, microscopes and measuring instruments namely meters, sitting scales, measuring cups (measuring the amount of water sprinkled), thermometers (measuring air temperature) analytical scales and bamboo samples.

Methodology

This study used a factorial randomized block design with two factors and three replications. The first treatment consisted of the level of shading (P) with 3 treatment levels namely (P0) without shading, (P1) 35% shading, (P2) 70% shading. The second treatment consisted of a variety of corn (V) with 6 varieties, namely the Exsotic Pertiwi variety (V1), Paragon (V2), Bonanza F1 (V3), Bisi 2 (V4).

Observation variables consisted of plant height, leaf area, level of greenness of leaves, amount of chlorophyll a and b, leaf temperature and net photosynthesis.

Research procedure

Polybag preparation. The dry soil after 5 days of air dry and then sieved with a 4 mm sieve while cleaning from impurities. The soil medium (top soil volume: sand : compost = 3:3:2) is mixed evenly using a hoe. Put into each polybag as much as 5 kg. Then all the

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polybags were arranged in shelters and fields according to treatment.
The corn have been planting under the auspices of Oil Palm. The day before planting, the soil was given Furadan as much as 0.2 g per hole to ovoid attacks of seed fly. Each polybeam was planted with 2 corn seeds + 2 cm deep and covered with soil.

Maintenance
Watering is done manually as much as 500 ml of water/polybag/day unless there is sufficient rainwater on that day. Three to 6 days after planting, embroidery is carried out on plants that do not grow. Pest prevention is carried out by spraying Decis 2.5 EC insecticide at a dose of 0.7 ml/liter of water starting 2 weeks after planting and repeated every 2 weeks until 1 week before harvest..

Harvest
The harvesting of corn plants have been done when the plants are 80 to 100 days after planting. The collecting of corn has been done by picking the corn cobs from the stalk of plants.

RESULTS AND DISCUSSION

Research result

Plant height (cm)

From the results of observations and analysis of variance, it can be seen that the treatment of the level of shade showed a very significant effect at the ages of 2, 4 and 6 week after plant (WAP) and the treatment of various varieties showed no significant effect at the age of 2 WAP but had a significant effect at the ages of 4 WAP and 6 WAP. The interaction between the treatment level of shade and the various varieties of maize showed no significant effect at all observed ages.

The results of the mean difference test for the effect of the treatment level of shade and various varieties of corn on the height of the corn plants aged 6 WAP can be seen in Table 1.

Table 1. Plant height (cm) of 4 varieties of corn in different percentage of shade and Varieties at 6 weeks after plant

P/V	V_1	V_2	V_3	V_4	Mean
P_0	80,00a	94,67a	104,73 a	100,70a	95,03 b
P_1	102,83 a	109,92a	116,83a	126,33a	113,98 a
P_2	110,75a	113,58a	113,25a	111,47a	112,26 ab
Rerata	97,86 b	106,06 a	111,61 a	112,83 a	-

Keterangan: The numbers followed by the same letter in the same column show no significant difference at the 5% level according to the BNJ test

From Table 1 it can be seen that the percentage level of shading, with 35% shading (P1) showed the highest plant height at 113.98 cm, not significantly different from 70% shading (P2), namely 112.26 cm, but P1 was significantly different from the treatment (P0) without shading, at 95.03 cm.

In Table 1 it can also be seen that the treatment of the level of shade with treatment (V4) of the Bisi-2 variety showed the highest plant, namely 112.83 cm, not significantly different from the treatment (V3) of the Bonanza F1 variety, namely 111.61 cm and the treatment (V2) of the variety Paragon was 106.06 cm, but significantly different in treatment (V1) of the Exsotic Pertiwi variety, namely 97.86, while treatments V3, V2 were significantly different from treatment V1. The interaction between treatment levels of shade and various varieties of maize showed no significant effect at all observed ages.

The effect of the degree of shade treatment on plant height (cm) of corn aged 6 weeks after planting, can be seen in the response curve in Figure 1 below..

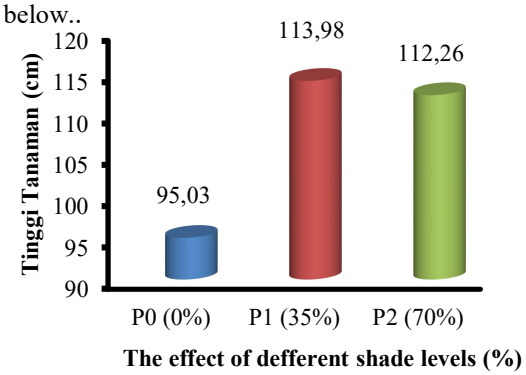

Figure 1. Histogram of Percentage of Shade Level Against Plant Height (cm) of Corn Age 6 Weeks After Planting

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The effect of the treatment of various varieties of corn on plant height (cm) of corn aged 6 weeks after planting, can be seen in the Histogram Figure 2 below.

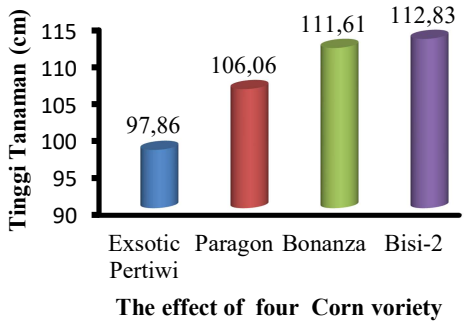

Figure 2. Histogram Histogram of Treatment of Various Corn Varieties to Plant Height (cm) of Corn Age 6 weeks after Planting

Leaf area

From the results of observations and analysis of variance, it can be seen that the treatment of the level of shade showed no significant effect at the ages of 4, 6 and 8 WAP and the treatment of various varieties showed no significant effect at the age of 4 WAP but had a significant effect at the ages of 6 WAP and 8 WAP. The interaction between the treatment level of shade and the various varieties of maize showed no significant effect at all observed ages.

The results of the mean difference test for the effect of the treatment level of shade and various varieties of corn on the leaf area of corn plants aged 8 WAP can be seen in Table 2.

Table 2. The percentage of Shade Level and Various of Corn Varieties on Maize Leaf Area at 8 week after planting

Table 2. Test Results of Treatment Means of Shade Level and Various Varieties of Corn on Maize Leaf Area Age 8 MST.

P/V	V_1	V_2	V_3	V_4	Rataan
P_0	2431,15	2889,20	2839,57	3259,26	2854,79a
P_1	1840,65	3189,37	3099,07	3652,71	2945,45a
P_2	2164,99	2845,08	2799,09	3405,27	2803,35a
Rataan	2145,26 c	2974,55 b	2912,57 b	3439,08 a	-

From Table 2 it can be seen that the treatment level of shading, with 35% shading (P1) shows the widest leaf area, namely 2945.45 cm, not significantly different from 70% shading (P2), namely 2803.35 cm, and treatment (P0) without shading that is 2854.79 cm.

In Table 2 it can also be seen that the treatment level of shade with treatment (V_4) The Bisi-2 variety showed the highest leaf area, namely 3439.08 cm, significantly different from the treatment (V3) of the Bonanza F1 variety, namely 291.57 cm, the treatment (V2) of the Paragon variety, namely 2974.55 cm, and the treatment (V1) of the Exsotic Pertiwi variety. namely 2145.26 cm, while the V3 and V2 treatments were not significantly different from each other but significantly different from the V1 treatment. The interaction between treatment levels of shade and various varieties of maize showed no significant effect at all observed ages.

The effect of the treatment of various varieties of corn on the leaf area (cm) of corn aged 8 weeks after planting, can be seen in the Histogram Figure 3 below.

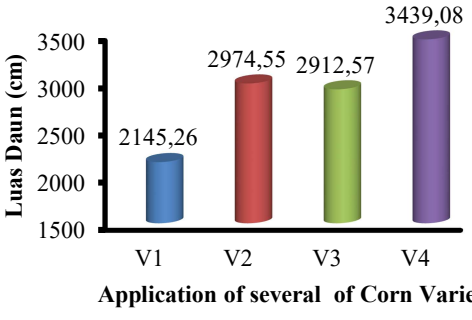

Figure 3. Histogram of Treatment of Four of Corn Varieties to Leaf Area (cm) of Corn Age 8 Weeks After Planting

The Chlorophyll content of Corn Leaves

Treatment of shade level and varietas differences as well as the interaction of the

two factors had no significant effect on chlorophyll content four varieties of corn leave as shown in Table 3.

Table 3. Comparison of Chlorophyll content four varieties of corn leaves at different Percentage of shading

P/V	V_1	V_2	V_3	V_4	Mean
P_0	36,83	37,33	37,67	35,83	36,92
P_1	32,53	37,70	36,17	35,57	35,49
P_2	35,13	35,10	33,07	35,00	34,58
Rataan	34,83	36,71	35,64	35,47	-

Keterangan : Numbers followed by the same letter in the same column show no significant difference at the 5% level according to the DMRT Test.

The treatment percentage levels of shade and different varieties tend to show the similarity in the quality of the greenness of the leaves so what is needed to know the chlorophyll content in the leaves?.

Total Chlorophyll-a and-b and total a and b.

The difference in percentage of shading showed a significant effect on chlorophyll-a and total chlorophyll-a and b. However, varieties and the interaction between shade levels and varieties did not significantly affect chlorophyll-a and total chlorophyll-a and b. Differences in shade levels, varieties and interactions between shade levels and varieties did not significantly affect of the amount of chlorophyll-b. The follow-up test is listed in Table 4.

Tablel 4. Total chlorophyll-a, chlorophyll-b and total chlorophyll-a and b content at various shade levels and varieties.

Treatment	Chlorophyll content		
	A	B	Total a+b
	……	mg/g bb	…
Percentage of Shading level			
P0 = without shading	5,16 a	3,27	8,43 a
P1 = 35% of shading	2,82 b	2,26	5,08 b
P2 = 70% of shading	4,43 ab	2,81	7,24 ab
Varietas			
V1 = Exotic Pertiwi	3,93	2,37	6,30
V2 = Parragon	3,68	2,44	6,12
V3= Bonanza F1	3,47	2,71	6,18
V4= Bisi-2	4,63	2,97	7,60
Kombinasi			
P0V1	5,47	3,05	8,52
P0V2	4,50	2,44	6,94
P0V3	5,56	3,41	8,97
P0V4	6,07	5,18	11,25
P1V1	3,01	2,20	5,21
P1V2	4,17	2,31	6,48
P1V3	1,53	2,81	4,34
P1V4	2,25	1,86	4,11
P2V1	3,56	2,18	5,74
P2V2	5,88	2,95	8,83
P2V3	4,44	2,56	7,00
P2V4	3,30	2,32	5,62

Information : Different letter notations in the same column and group show a significant difference at the 5% level according to the DMRT test.

The highest amount of chlorophyll-a was found in the treatment without shading, not significantly different from 70% shading level, but significantly different from 35% shading. The 35% shading level showed the smallest amount of chlorophyll-a but was significantly different from the 70% shading level. A similar phenomenon occurs in the total amount of chlorophyll-a and b.

Leaf temperature.

Treatment level of shade, differences in varieties and the interaction of the two factors had no significant effect on leaf temperature (^oC). This means that there is no significant change in leaf temperature even with different shade levels and varieties.

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Table 5. Leaf temperature at various shade levels and Corn varieties.

P/V	V_1	V_2	V_3	V_4	Mean
P_0	36,12	37,16	36,38	37,71	36,85
P_1	37,82	37,53	34,28	35,02	36,16
P_2	37,45	38,35	36,49	34,87	36,79
Rataan	37,13	37,68	35,72	35,87	-

The leaf temperature did not show a significant difference even though the amount of light received by the leaves was different, indicating a mechanism for stabilizing the plant's body temperature even though it was exposed to different heat due to the light received.

Net photosynthesis

Differences in varieties have a significant effect in producing net photosynthesis that is formed while the level of shade and the interaction of the two factors has no significant effect.

Table 6. Net photosynthesis at different shade levels and different varieties (µmol $m^{-2}s^{1}$).

P/V	V_1	V_2	V_3	V_4	Rataan
P_0	16,08	18,21	10,50	13,33	14,53
P_1	15,21	8,32	7,60	7,19	9,58
P_2	22,20	15,30	5,81	6,23	12,39
Rataan	13,37 a	10,46 ab	5,98 b	6,69 b	-

Keterangan : Different letter notations on the lines indicate significant differences at the 5% level according to the DMRT test.

The highest net photosynthesis was obtained by the Exsotic Pertiwi variety, followed by the Paragon variety. The lowest net photosynthesis was obtained by the Bonanza F1 variety which was not significantly different from the Bisi-2 variety, the Bonanza F1 variety was also not significantly different from the Bisi-2 variety.

The effect of the treatment of various varieties of corn on net photosynthesis can be seen in the histogram in Figure 4.

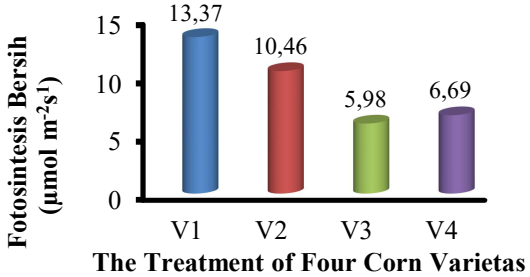

Figure 4. Histogram of Treatment of Various Corn Varieties on Net Photosynthesis

According to (Elfarisna, 2000) plant height is very significantly affected by shade, the higher the level of shade, the taller the plant. Plants that experience stress from low light intensity will increase plant height to increase light capture efficiency. According to (Taiz & Zeiger, 2012) that plants that grow in conditions of low light intensity will experience a longer juvenile phase or return to being juvenile. In addition, the main cause may be that in low-intensity conditions, it reduces the supply of carbohydrates to the apices, even though carbohydrates, especially sucrose, play an important role in the transition from juvenile to adult.

The process of photosynthesis increases with the higher intensity of solar radiation so that the growth rate and yield are also higher. The plant factor that has the most contribution to the utilization of solar radiation is the leaf area index (ILD) in

relation to the percentage of solar radiation that can be utilized by plants. If the leaf area index is too small, very little intercepted solar radiation, most of the radiation that reaches the ground surface is then reflected, absorbed and emitted so that the temperature becomes high. Conversely, if the ILD is too large, which means the leaves shade each other, most of the solar radiation that reaches the soil surface can be absorbed by the plants. However, the leaves that are shaded are not reachable and eventually become consumers and parasites for plants so that the growth rate of plants becomes slow. At the optimum ILD, the higher the intensity of solar radiation, the plant growth rate will increase (Las, 1982).

The level of shade affects the growth and development of corn plants. The results of research (Rogi et al., 2020) in (Hamdani & Susanto, 2020) show that the amount of C4 with characteristics is very sensitive to shading. Shade on these plants during the development phase can reduce seed weight and affect the length of the internode (Fournier & Andrieu, 2020). The results of the study (Rogi et al., 2020) show that the amount of solar radiation absorbed by corn plants under 5-year-old and 50-year-old coconut stands is higher than that of 20-year-old coconuts, so corn cultivation is not recommended to be carried out between coconuts. 20-30 years because it will lead to reduced production. Selection of corn varieties that are tolerant to low light is the right way to develop these plants in standing lands. The results of the study (Purnomo, 2015) showed that the Pioner 11 variety of maize was capable of producing up to 3.9 t/ha at shade levels of up to 60%. Furthermore (Syafrudin et al., 2014) reported that there were 9 maize genotypes that were tolerant to low light intensity.

Light affects plant growth and development in many ways. Light affects the vegetative growth of plants because of its effect on photosynthesis, leaf temperature, water balance in plants and photomorphogenesis, namely plant growth and development which is directly controlled by light and does not depend on photosynthesis (Ting IP, 1982). The impact of sunlight deficit due to shade on itchgrass {Rottboellia exaltata L.f.) can be seen from the decrease in dry matter and stomatal resistance (Patterson, 1979).

In this study, the intensity of the shade increases, the number and size of stomata decreases, this is thought to affect the diffusion of CO2 to the leaves because stomata play an important role in CO2 exchange. (Fitter & Hay, 1981) stated that stomatal response to shade is a plant adaptation to environmental changes to inhibit CO2 diffusion. In addition, at low light levels, intercellular CO2 concentrations can be the main controller in photosynthesis (Salisbury & Ross, 1992). This resulted in a decrease in plant growth in plant species that are intolerant of shade such as pule in this study.

In general, each type of plant has a different effect on the light it receives. (Kurniaty et al., 2014) stated that light intensity that is too low will produce photosynthetic products that are not optimal, while light intensity that is too high will affect the activity of leaf stomata cells in reducing transpiration resulting in inhibition of plant growth. Therefore, optimal light intensity is needed so that plant growth can be maximized and can produce good quality.

Plants that experience shade stress will make adjustments, for example changes in plant morphological and physiological characters. In conditions of lack of light, plant growth will be disrupted as a result of a lack of supply of energy and ATP needed in the process of photosynthesis (Niinemets, 2015).

CONCLUSION

The best plant height parameter in the shade level treatment showed 35% shade (P1) resulted in the highest plant height of 113.98 cm, while in the Variety (V4) Bisi-2 variety treatment showed the highest plant, namely 112.83 when compared to other varieties. The effect of various varieties on leaf area showed a significant effect at the age of 6 and 8 WAP. The degree of shade and differences in varieties show the similarity in the quality of the green leaves. The level of shade showed a significant effect on chlorophyll-a and total chlorophyll-a and b where the highest

amount of chlorophyll-a was found in the treatment without shade, which was not significantly different from the level of 70% shade, while varieties had a significant effect in producing net photosynthesis formed.

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BIBLIOGRAPHY

Elfarisna. (2000). *Adaptasi Kedelai terhadap Naungan: Studi Morfologi dan Anatomi*. Institut Pertanian Bogor.

Fitter, & Hay, R. K. M. (1981). *Enviromental Physiology Plants. Academic Press*.

Fournier, & Andrieu. (2020). Dynamics of the elongation of internodes in maize (Zea mays L.). effects of shade treatment on elongation patterns. *Annals of Botany*, *86*, 1127–1135.

Gliessman. (2016). *Multiple Cropping Systems: A Basis for Developing an Alternative Agricultur*. Environmental Studies University of California.

Hamdani, K. K., & Susanto, H. (2020). Pengembangan Varietas Tahan Naungan Untuk Mendukung Peningkatan Produksi Tanaman Pangan. *Jurnal Planta Simbiosa*, *2*(1).

Kurniaty, Budiman, & Suartana. (2014). Pengaruh media dan naungan terhadap mutu bibit suren (Toona sureni MERR). *Jurnal Penelitian Hutan Tanaman*, *7*(2), 77–78.

Las. (1982). *Efisiensi Radiasi Surya dan pengaruh Naungan Fisik terhadapPadi Gogo*. Institut Pertanian Bogor.

Mahdiannoor, & Istiqomah, N. (2015). Growth and Yield Two Corn Hybrid As Intercropping Under Rubber Plants Stands. *Ziraa'ah*, *40*(1), 2005.

Niinemets. (2015). A review of light interception in plant stands from leaf to canopy in different plant functional types and in species with varying shade tolerance. *Ecological Research*, *25*(4), 693–714.

Patterson. (1979). The effect of shadding on the growth and photosynthetic capacity of itchgrass (Rottboellia exaltata L.f). *Weed Science*, *27*(5), 549–553.

Purnomo. (2015). Tanggapan varietas tanaman jagung terhadap iradiasi rendah. *Jurnal Agrosains*, *7*(1), 86–93.

Rochmah, H. F., Suwarto, & Muliasar, A. A. (2020). Optimasi Lahan Replanting Kelapa Sawit Dengan Sistem Tumpangsari Jagung (Zea mays L) Dan Kacang Tanah (Arachis hypogaea). *Jurnal Simetrik*, *10*(1), 256–262.

Rogi, Kalangi, Rombang, Lumingkewas, Tumbelaka, & Paskalina. (2020). Produktivitas jagung (Zea mays L.) pada berbagai tingkat naungan tanaman kelapa (Cocos nucifera L.). *Buletin Palma*, *38*, 49–59.

Salisbury, & Ross. (1992). *Plant Physiology*. Prentice Hall.

Syafrudin, Suwarti, & Azrai. (2014). Penyaringan cepat dan toleransi tanaman jagung terhadap intensitas cahaya rendah. *Jurnal Penelitian Pertanian Tanaman Pangan*, *33*(1), 36–43.

Taiz, L., & Zeiger, E. (2012). *Plant Physiology.The Benyamin/Cummings Pub. Co.*

Ting IP. (1982). *Plant Physiology*. Addisson Wesley Publ.