

Growth and Production of Some Variety Corn (*Zea mays* L.). Planted under the Canopy of Palm Oil 12 Years Old in Swamp Land

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Abstract. This research was conducted in wetlands Semambu Village, District of North Indralaya, Ogan Ilir, South Sumatra Province, Indonesia, which lasted from July 2015 to February 2016. The observation of a microclimate indicate that the average intensity of light outside the auspices of the plot $1968.9 \text{ m}^2 \text{ s}^{-1} \text{ mol}^{-1}$, under waranet $1502.40 \text{ mol}^{-1} \text{ m}^2 \text{ s}^{-1}$, below paranet $721.99 \text{ mol}^{-1} \text{ m}^2 \text{ s}^{-1}$ and under waranet $439.25 \mu\text{mol m}^2 \text{ s}^{-1}$ - equivalent to the light interception 1 or 100%, 76%, 37% and 22%. Results of soil chemical analysis that the soil has a low fertility study (H_2O pH of 3.32, organic C 4.47%, total N 0.35%, Bray P 13.30 ppm, K-ea 0.26 me / 100g, CEC 19.6 me / 100g and Al-ea 3.28 me / 100g). Tests on 22 genotypes of maize grown with light interception 100%, 76%, 37% and 22%, by calculating tolerance index based on the weight of dry seed cob-1 was found four genotypes of maize tend to be tolerant to low-intensity light that were genotype B 41, Pioneer 27, Sukmaraga and Sugihan. The test results of corn planted in beds shade with light interception 100%, 76%, 37% and 22% for groups of maize tolerant and sensitive, followed by application of urea 0 kg ha^{-1} , 100 kg ha^{-1} , 200 kg ha^{-1} , 300 kg ha^{-1} and 400 kg ha^{-1} indicate that maize and 41 and Pioneer 27 by Urea 300 kg ha^{-1} gives better results than other varieties at different intensities of light oil palm age of 12 years with applications Urea fertilizer 300 kg ha^{-1} , indicating that the B 41 and Pioneer 27 tends to give better results compared with other varieties. The application of a polyculture system palm-maize can produce 1000 kg of dry grain of corn in a 1 ha of oil palm cultivation.

1. Introduction

The Republic of Indonesia today is faced with various problems that are global, national, regional and even sub-sub-regional. These issues must be given a conceptual response comprehensive and totality. One of them is the development of the agricultural sector. Indonesia faced with the problem of realization of national food security and improving the welfare of farmers.

Therefore, the Ministry of Agriculture will give priority to the development and optimization of specific technologies that are technically relevant to the condition of the land, and land development



suboptimal. One effort that can be done is suboptimal land development, namely swamp (lowland, wetland), which are very widespread in Indonesia [1].

Vast swamp land in Indonesia is estimated at 33 million ha, consisting of tidal land and 20 million ha of lowland swamp 13 million ha [2]. Furthermore, Subagyo [3], explains that the lowland swamp land in addition to rice production centers, it has also become a regional maize production. This is evidenced by the results of research Rosmiah *et al.*, [3] and Marlina *et al.*, [4], that the production of corn and sweet corn can be increased in the swampy wetlands with biological organic fertilizer. Maize cultivation in the swamp in which is still conventional become essential to most places. Corn generally grown in paddy fields after rice in monoculture, land surjan continuously with monoculture and in intercropping surjan land with plantations or horticultural crops (such as cocoa, citrus). Corn productivity in wetlands is very diverse. The results of the research in Karang Agung, South Sumatra Province showed yield of corn in the wetlands around 3.5-5.5 ton dry seed ha⁻¹, depending on the typology of land, varieties, and the input of ameliorant and fertilizers [5].

In the national economy, corn contributor (GDP) is the second largest after rice in food crops. Donations corn to Gross Domestic Product (GDP) continues to increase every year, even during the economic crisis. In 2000 the contribution of maize in the national economy reached Rp 9.4 trillion and in 2003 increased to Rp 18.2 trillion. These conditions indicate the magnitude of the role of corn in spurring the growth of food crops and the national economy in general.

The productivity of oil palm growers are also extremely low at only 5 tons - of fresh fruit bunches ha⁻¹ yr⁻¹, which is far from the existing potential is 20-30 tons of fresh fruit bunches per hectare per year. Oil palm plantations belonging to the people of an area of 3.01 million hectares, or 40.15% of the total national oil palm plantations [6]. That area could potentially big enough to be developed through a pattern of polyculture with maize as a crop sidelines.

To overcome the various problems faced by farmers wetlands, with principle to coordinate the desire of farmers to have a garden of palm oil, while maintaining the function of wetlands as buffers national food availability. One effort that can be developed through plant-based oil palm polyculture cropping with crops. Paddy fields or non-paddy fields have turned into oil palm monocultures immature still cultivated rice cultivation in the first planting season and maize planting season II. Thus the intensification of polyculture in palm oil plantation area can help contribute rice and maize production from Lebak swamp. The existence of oil palm on land that has been over the function will take place until one cycle is 20-25 years. Therefore there is a time lag between 10-15 years of a cycle of oil palm with the potential to do the cultivation of maize. Polyculture aims to improve the biological and economic results from a field in it is so associated with the type of crops grown and the population in one unified system of cultivation or planting patterns [7][8]. Furthermore Purnomo [9] explains that the introduction of maize as a crop is plagued by low production stream. Low productivity is related to the intensity of light at the bottom of the stand which is low compared to the open, in addition to be competition between plants for nutrients and water.

As the plant among palm, maize varieties appropriate election will determine the level of productivity that can be achieved. Atman [10] concluded that the use of varieties of composite or hybrid varieties recommended in corn cultivation under the canopy of coconut trees. Mohr and Schopfer [11] stated that the plant's ability to tolerate shade is determined by the genetic properties of plants. Nevertheless, the appearance of a variety depends on the interaction of genetic and environmental factors [12]. Research by Rochman *et al.* [13] revealed that on in wetlands is still no specific varieties appropriate for use farmers as a whole and evenly.

Information on plant responses to light with several treatments have sufficient level of shade available, but information on maize varieties tolerant of low light, especially corn are cultivated with oil palm is still limited. Although corn as C₄ plants have different responses to light compared with C₃ plants because of the different characteristics of photosynthesis, need to be tested because it is possible that there are varieties of corn that is tolerant of low light has the potential to be developed as intercrops under palm canopy has produced.

In recent decades wetlands as buffers national food production is threatened by the emergence of the phenomenon of the transition function of wetlands into oil palm and rubber plantations or non-agricultural [13]. According to Minister of Agriculture [14] over the wetland function reaches 100,000 ha per year either by plantations and non-plantation. This phenomenon is of course a major threat to national food security and the government's efforts in achieving self-sufficient food. Agricultural development wetlands have become a mainstay for increased production of food crops. With proper management through the application of appropriate science and technology, wetlands have great prospects for development into productive agricultural land, especially in order to preserve food self-sufficiency, diversification of production, income generation and employment, as well as agribusiness development area [15].

2. Materials and methods

Land availability optimal depletion of food due to land conversion, has prompted the government to shift food production to sub-optimal land, including for wetlands, both in swampy bogs and in the tidal marsh.

The pattern of palm plantations is also growing rapidly in a swamp area with conventional cropping systems (monoculture), the number of oil palm plantations on these systems varies between 130-148 plants per hectare so that they have a growing space (space between canopy) which allows for growing crops between rows of corn as a staple crop plants sidelines, especially when oil palm age of 3-6 years with using corn crop varieties tolerant or adaptive low light (shaded). Palm frond that has been completely closed space between the plants would cause the intensity of light is the main constraint development patterns of poly-corn oil.

The corn crop is grown in lowland swamp as the plants will suffer from stress light, and a variety of stress-induced marginal land conditions, resulted in a decrease in the rate of metabolism. These stresses will look at the symptoms of physiological, morphological and anatomical plants resulting in low production of biological crops. Information about the various plant responses to low light (shaded) is sufficient available, but the information of the corn is tolerant of low light is still very limited. One of the technologies that will enhance the production of maize as a crop stream is through varieties tolerant of low light, followed by the input of technology-specific fertilization.

Besides the low light intensities as the cause of low production of corn, swampy bog fertility factor is also a determinant of productivity. Various efforts to improve the quality of wetlands has also done many of them by giving ameliorant (pH soil improvement materials such as limestone), the addition of organic material. organic fertilizers and inorganic fertilizers. Information on this matter has been sufficiently available, but the corn crop fertilization action information specific locations as plant sidelines are not yet available.

The addition of nitrogen nutrients through fertilization is believed to increase the rate of photosynthesis through increasing the chlorophyll content of leaves and increased levels of the enzyme ribulosebiphosphate carboxylase / oxygenase (Rubisco). Adequacy of Rubisco could be expected to improve the adaptability of plants through (1) the mechanism of increasing the efficiency of light absorption ("efficiency of light trapping"), and (2) the mechanism of low light tolerance (tolerance of light deficit).

The mechanism of adaptation to light reflected from changes in leaf characteristics such as leaf area index (LAI), weight specific leaf (BDS), the content of chlorophyll a and chlorophyll b and the ratio of chlorophyll a and chlorophyll b, reducing the reflection of light, a reduction transinisi light and reduction khloroflas non pigmented. With the addition of nutrient nitrogen through proper fertilization and specific conditions of the swamp is expected to overcome the negative effects of low light intensity. To achieve the goal of optimizing the biological production of corn plants that was developed at the space in between trees of oil palm plantations in wetlands need to do a series of studies initiated from the inventory of the condition of the field and light interception in the canopy of palm, testing the tolerance of corn varieties to low-light conditions, efforts to increase production

through nitrogen fertilization in corn shaded conditions and testing different varieties of corn that were given extra nitrogen in the space between rows of oil palm plantations have produced.

Plot trials made with a size of 2 m x 1.5 m by 8 plots in oil palm canopy 12 years old, the distance between subplots within 50 cm and between replications 8 meters (distance canopy of palm). Number of plots within one repetition is 8 plots. Two weeks before planting given Dolomite 6 tonnes / ha, three days before planting Furadan 3 G sprinkled evenly over the surface of the plot as much as 15 kg ha⁻¹. Seeds planted by ditugal as much as 1-3 seeds per planting hole by using a spacing of 75 cm x 25 cm and a week after growing thinning with one plant per hole. Manure in the form of chicken manure with a rate of 2.5 ton / ha given at planting. NPK fertilizers, such as urea 400 kg / ha, SP-36 225 kg ha⁻¹ and 125 kg KCl / ha. Fertilization is first given 45 SP-36 kg, 25 kg KCl / ha and urea 20% of the dose given appropriate treatment at the plant age 10 day after planting (DAP). Fertilization both SP-36 90 kg, 50 kg KCl / ha and 40% urea according to treatment at 30 DAP. Fertilization third given both SP-36 90 kg, 50 kg KCl / ha and 40% urea according to treatment at age 50 DAP. The fertilizer is given the array within 5-10 cm side row of plants along with hoarding and mechanical weed control.

Final plant height observations done at age 65 DAP, together with sampling for observation leaves leaf area, specific leaf area. Observations of chlorophyll a and b and total leaf chlorophyll. Observation of leaf dry weight using oven with a temperature of 70 ° C for 48 hours. Measurement of leaf area, then, by measuring the length and width of leaf samples, calibrated using leaf statue meter to determine the constant of leaf area index. Next, the total leaf area leaf area is determined by multiplying the sample with the average number of leaves of the plant samples at the last observation. Specific leaf area determination by comparing the sample divided leaf area leaf dry weight of the sample, (Dry weight of leaves using an oven temperature of 70 ° C for 48 hours). Root dry weight at the end of the study by taking the roots washed and then dried in an oven (at 70 ° C for 48 hours). Observation components of the production is done when the corn cob was physiologically mature. and the wind dried cob weight measurement.

3. Results and discussions

3.1. Results

Microclimate conditions under the canopy of palm oil during the study as shown in table 1, shows that the average light intensity M2S 430 mol⁻¹, an average temperature of 34°C and humidity is 66.24%.

Table 1. Microclimate conditions under the canopy of palm ages 0-12 years.

Climatic components	Observation				Average
	I	II	III	IV	
Light intensity (μmol m ² s ⁻¹)	487.67	397.33	412	425	430.50
Temperature (°C)	33.77	34.43	34.87	35.20	34.57
Humidity (%)	78.78	76.21	73.5	76.47	75.23

Results of analysis of variance to the observed variables indicate that the treatment effect is significant on plant height, number of chlorophyll a and b, the number of leaves, leaf length, leaf area, segment length, cob without the husk, the weight of dry seed cob⁻¹, the weight of dry seed ha⁻¹, except the leaf width, treatment effect was not significant (table 2).

Further test results with the smallest difference test. in Table. 2. the group CIR tolerant maize varieties. show that varieties B 41 which has the highest plant height (184.0 cm) and leaves the longest (80.33 cm) was statistically different from the other varieties.

Corn Pioneer 27 have the highest number of leaves (13.16 strands). the highest weight of cob without husk (89.58 g) and the weight of the highest shelled cob-1 (99.12 g). Sukmaraga shows the widest leaf width (7.83 cm) and the longest segment (12.66 cm).

Table 2. Results of analysis of variance varieties influence on the observed variables.

Variable	Variety	CV (%)
Plant height	**	8.72
Number of leaves	**	10.86
Length of leaves	**	10.1
Width of leaves	Ns	11.75
Length of steam	**	12.86
Dry weigh of cob no husk	**	12.86
Dry weight seed cob ⁻¹	**	14.37

Sugihan being the lowest for all the observed variables. Meanwhile, the corn-sensitive group CIR. dry seed weight of cob-1 obtained at the highest local varieties of maize. Tg.lago (67.25 %).

Table 3. Effect of different varieties of maize to the observed variables.

Variety	Plant height	Number of leaves	Length of leaves	Width of leaves	Length of segment	BTTK	BPPKT
B41	184.00 B	13.00 B	80.33 B	7.06 A	12.58 B	82.66 BC	83.62 B
Pioneer 27	179.58 B	13.16 BC	76.83 A	7.50 B	10.66 A	89.58 BC	89.12 B
SMRG	187.75 B	11.16 A	79.75 B	7.83 BC	12.66 B	75.16 B	83.68 B
Sugihan	176.25 B	11.91 B	74.08 A	7.22 A	11.50 B	78.91 B	89.37 B
L164	168.58 A	10.25 A	75.16 A	6.37 A	11.08 A	56.54 A	54.00 A
NT105	154.00 A	10.25 A	69.75 A	6.18 A	12.91 B	67.83 A	57.12 A
LMR	160.83 A	10.91 A	66.91 A	6.16 A	9.25 A	62.62 A	63.25 A
TG LAGO	163.18 A	10.08 A	79.91 B	6.56 A	11.75 B	63.58 A	67.25 A
BNT 0.05	22.03	1.81	11.19	1.18	2.18	13.44	16.04

3.2. Discussion

Generally shade formed by the canopy of palm oil ranges from 50% -80% depending on the age of the palm. Low-intensity light effects that will continually affect the growth of corn, since the phase of seed germination to process pematengan response to various corn varieties, fertilizers Urea with the same doses, it produces two groups of plant height. CIR-tolerant varieties have plant height were not significantly different. The same thing happened to a group of plants that are sensitive CIR. The condition is thought to be due CIR tolerant maize plants still have a better metabolism, thus increasing plant height.

Corn B 41 and Pioneer 27 have a number of leaves more than other varieties. This is allegedly due to the optimal utilization of nitrogen by two of these varieties, although in limited light intensity conditions. Utilization of nitrogen through the mechanism of PEP-karboasilase can stimulate the accumulation photosintat so that the number of leaves more. The same thing happened to the length and width of leaves. B 41 segment length of about 1-2 cm longer than the sensitive group of corn CIF, except for NT 105. The length of this segment is in response CIR tolerant plants to increase plant height due to increased activity on the network meristim auxin.

In terms of the result of dry seed cob⁻¹ crop⁻¹ and weighs cob without husk varieties of Pioneer 27 and B 41 to give hope to be developed as a crop stream on gawangan palm (polyculture oil palm plantations-corn) with the ability of the results of dry seed ha⁻¹ reaches 5:25 tons for Pioneer 27 and 4.96 tons respectively. B 41 and Pioneer 27 are varieties with high stem growth with the number of leaves, leaf width and length greater than the other varieties. So, it is thought to have the ability to capture more light and with the availability of sufficient nitrogen and supported by micro-environmental conditions with optimum temperature for growth of corn with the air humidity is high enough, it is supposedly enables optimal rate of photosynthesis will result fotosintat better. Fotosintat

results will be stored in the form of grain or cob. This statement is supported by Kusumasari *et al.* [15] which states that a sturdy root system and is capable of high production in a variety of soil conditions and can be classified as corn that is tolerant of low light intensity and B 41 is a strain of corn that efficient nutrient [16].

4. Conclusions

4.1. Conclusion

From this study, it can be concluded that the maize varieties of B 41 and Pioneer 27 (group tolerant CIR) can grow and develop quite well on below canopy of oil palm age of 12 years, that the adoption of polyculture palm-corn with levels of occupational planting 0.7 and the area to be planted 0.4 ha, and that from one ha of oil palm planted monoculture with genotypes of B 41 and Pioneer 27 can be generated approximately one ton of dry shelled corn.

4.2. Recommendations

Further research is needed to determine optimal spacing of oil palm (wide distance canopy) which allows the interception of light optimal for the growth of maize as polyculture in oil palm plantations (intercrops) because in this study observation was not conducted for optimal LAI palm.

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