IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)
e-ISSN: 2319-2380, p-ISSN: 2319-2372. Volume 14, Issue 1 Ser. III (January 2021), PP 55-60
www.iosrjournals.org

Solar Radiation Problem of Oil Palm Cultivation *Elaeisguinensis*Jacq) On High Elevation Land Ex Tea (*Camellia sinensis*) Plantation At Simalungun, North Sumatera Province – Indonesia

MardianaWahyuni
STIPER- Agrobisnis Perkebunan (STIPAP), Medan-Indonesia

Abstract: *Taking into account the economic aspects and the increase in air temperature due to global warming, some tea plantations in North Sumatra have been converted to oil palm plant. Land and agro-climate characteristics are the basis of plant cultivation in order to grow and produce optimally. The research was conducted at Kebun Bah BirungUlu using a descriptive design. The location is at an altitude of 600-900 m above sea level, the land is in the S3 class (moderate suitable) with an average rainfall of 3616 mm / year, solar radiation 3.7 hours / day (intensity 44.1%), humidity 85.6% and an average temperature of 23.3%. The object of study on the plant conversion in 2004, 2005 and 2006, planting material is DxP PPKS. The problems that occur are vegetative growth exceeds normal standards, delay of fruit maturity and high incidence of fruit rot disease. With a change in spacing to 105 trees / ha, high dose fertilizer application of 8-9 kg / tree, the average productivity is 20.41 tonnes / ha or 96.7% compared to the IOPRI standard which is 21.1 tonnes FFB / ha.*
Keywords*: Oil Palm, Global Warming, Conversion, Solar Radiation, Fresh Fruit Bunch*.

Date of Submission: 20-01-2021 Date of Acceptance: 04-02-2021

I. INTRODUCTION

Oil palm (ElaeisguinensisJacq) is developed on a wide scale in Indonesia because it is able to become one of the mainstays of the economy in absorbing labor, increasing welfare and a source of foreign exchange. According to statistical data from the Directorate General of Transportation (2018), the area of oil palm plantations in Indonesia is ± 14 million ha with concentrations mainly on the islands of Sumatra and Kalimantan.

In the competition for marketing prices between commodities, several areas of rubber, coconut, cocoa, sugar cane, tobacco and tea plantations have been converted to plantations with oil palm (Siagian, 2013). The land and climatic characteristics form the basis for the suitability assessment for planting each commodity. Lubis (2008) suggests that the optimum conditions for oil palm cultivation are at an altitude of 0 - 400 m above sea level, climate types AF and AM (according to Koppen) or A, B and C (according to Smith & Ferguson) with average rainfall. 1,750 - 2,500 mm / year which is evenly distributed, the temperature is 24 - 28ºC and the sunshine lasts 5 - 7 hours / day.

One of the opportunities and challenges is the conversion of tea plants grown on high-relevance lands to be replaced with oil palm trees. Mearus (2000) and Simangunsong (2005) suggest that starting in the early 1990s due to global warming due to greenhouse gases there has been an increase in the annual average temperature to> 18ºC; So this has implications for the prospect of expanding oil palm trees in former tea plantations, especially those in North Sumatra Province.

Considering the relatively easy oil palm cultivation system, the selling price of the commodity is quite good because as one of the basic needs of food, one of the state-owned companies, namely PT. Perkebunan Nusantara IV has converted several tea gardens in Simalungun Regency to plant oil palm plants.

Land Suitability Class (MPA) is a quantitative description of the main growth factors for classifying land into S (Suitable) and NS (Non Suitable) classes. Limiting factors on ex-tea plantation lands are of particular concern so that oil palm plants can grow and produce optimally.

This study aims to evaluate the limiting factors of land suitability with a focus on climatic factors in the development of oil palm cultivation on ex-tea plantations.

II. MATERIAL AND METHODS

1. Research Location

The study was conducted in the ex-tea oil palm plantations, namely Bah BirungUlu Plantation, located in Simalungun Regency, North Sumatra Province. The coordinates of the location are 02º51′51″ North Latitude, 98º57′30″ East Longitude with altitude varies between 600 - 900 m asl.

2. Tools and Materials

The tea plant (Comellasinensis) has been planted since the Dutch colonialism and from 1996 it has been gradually converted. The focus of the study was on oil palm trees planted in 2004, 2005 and 2006 (including the mature plant category).

The oil palm plant material planted is DxPSimalungun (from the Palm Oil Research Center) with the characteristics of an average production of 28.4 tons of FFB / ha / year, oil yield of 26.5%, CPO production of 7.53 tons / ha / year, high growth. stem is 75 - 80 cm / year.

3. Research Design and Stages

This study used a descriptive design by examining climate data (temperature, rainfall, intensity of solar radiation) and its relationship with plant growth and productivity

III. RESULT AND DISCUSSION

a. Land Suitability Class

According to a survey report by Kartika et al (2016), soils in the Sidamanik area and its surroundings (including Bah BirungUlu) are included in the Inceptisol order (Dystriudepts) which is a group of young soils formed from volcanic eruptions with varying soil acidity (pH) characteristics. between 4.5 - 6.5, the texture of sandy loamy or sandy clay soil, depth of solum> 100 cm, the value of cation exchange capacity was in the medium category.

Based on the elements of determining the PPKS land suitability class (Lubis, 2008), there are 9 criteria that become the main priority in the assessment, namely elevation, rainfall, dry months, texture, drainage, topography, solum, presence of rocks on the surface and soil pH. Bah BirungUlu Farm is included in S3 class land (somewhat appropriate) with the understanding that S3 land is land that has more than one moderate limiting factor and a weight limiting factor that cannot be repaired (by humans), among others, is the height of the place because it is located at altitude 600 - 900 m above sea level and the amount of excessive rainfall.

b. Climate Factors

The results of the observations of the elements, climate are in Table 1.

Table 1. Climate Element Data (2013-2018)

No	Component	2013	2014	2015	2016	2017	2018	2019	Average	Standard	Evaluation
1	Rainfall (mm)	2.995	2.436	2.603	4.053	4.713	4.234	4.275	3.616	2000-2500	+
2	Solar radiation										
	Length(hour/day)	3,74	3,89	3,91	3,59	3,50	3,74	3,74	3,7	5 s/d 7	-
	Intencity (%)	42	48	49	44	42	42	42	44,1	75-90	-
3	Humidity (%)	86	86	87	84	86	85	85	85,6	86	+
4	Temperature (ºC)										
	Average	23	23	23	23	24	23	24	23,3	25-28	-
	Maximum	27	27	28	27	28	28	28	27,6	29-32	-
	Minimum	20	20	20	20	20	20	20	20	18-24	N

Notes: * Data from Wahyuni (2017) and updated with data from Kebun Bah BirungUlu (2019); + (excess), N (normal), - (less than standard)

The climate classification in Bah BirungUlu is classified as type A or very wet (according to Smith & Ferguson) with a Q value of 0.036.

From the data description in the table, the elements of climate that are excessive (above the standard) for oil palm plantations are the amount of rainfall and humidity. Excess rainfall with a long enough duration will reduce the photosynthetic period (Corley, 1987). With the topography of the garden, which is hilly, the management has taken physical soil preservation measures, namely by making contour terraces and planting legume cover crops, namely Mucunabracteata with the aim of slowing down surface runoff or controlling erosion.

A high humidity factor of 86% has an impact on the fruit forming process. Susanto, et al. (2003) argued that the presence of excessive rainfall and humidity resulted in disruption of the pollination process because

pollen (pollen) was humid with high water content so that it was difficult to be flown by the wind or the oil palm pollinating insect, Elaedobiuskamerunicus, to reach female flower pollen. Besides, the series of male and female flower bunches are inhibited from opening because naturally hot conditions are needed so that the sheaths of flower bunches can naturally break (Corley, 2003). According to Eden (1976), the growing requirements for each plant are unique, tea plants are suitable for planting in high elevation areas with low temperatures. Another impact with high humidity will be an increase in pod rot disease caused by the Marasimiuspalmivorus fungus, especially when the canopy conditions of the plant canopy are closed (Susanto, et al, 2016).

The climatic element that becomes an obstacle in this study area is the lack of solar radiation with an average of 3.68 hours / day or an intensity of 45.9%. Harley et al 1984 stated that the minimum requirement for oil palm trees is 5 hours / day and in certain months the plants require 7 hours / day of irradiation. In areas with high rainfall, the result is reduced sun exposure, namely <4 hours / day.

If the condition of the lack of intensity of solar irradiation continues for 3 months, it will result in a 16% reduction in productivity with a time lag (time lack) of 12-24 months. (Corley 2 et al 1987)

The distribution pattern of rainfall, evaporation and duration of sun exposure is presented in Figure 1.a. and Figure 1.b.

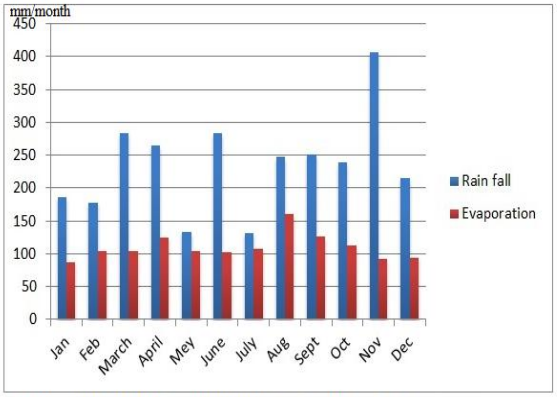

Figure 1.b. Monthly rainfall and evaporation patterns

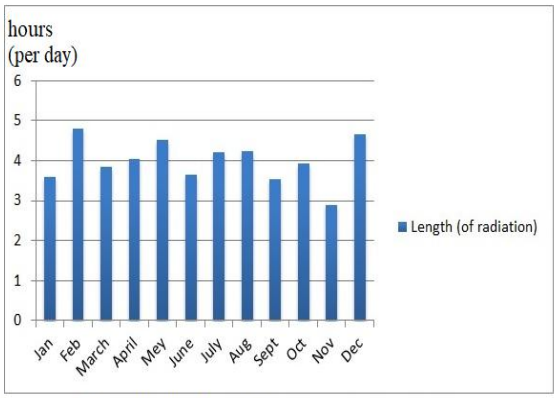

Figure 1.b. Length of solar radiation pattern

From this graph, the distribution of rain is almost evenly distributed throughout the year and in each month from June to December it is included in the category of wet months with rainfall> 100 mm / month. The long pattern of sun exposure is consistent, always less than the growing requirements.

Kieshu et al (2014) stated that the lack of solar radiation can interfere with the photosynthesis process, damage DNA and disrupt the formation of carotene in red algae (Rhodophyta). This is in line with the results of the research by Listia et al (2015) that the carotene content of oil palm fruit planted at an altitude of 368 m asl is 590.8 ppm while at an altitude of 865 m asl is 447.8 ppm (75.7%). Rhedergen et al (2016) stated that if the conditions are not met, it can reduce plant productivity by 4.8 tons of Fresh Fruit Bunches (FFB) / ha / year.

Writhez (2017) argues that it is important to increase the efficiency of the use of sunlight (Radiation Use Efficiency), among others, by maintaining good plant maintenance. It was also stated that the interception of solar radiation is influenced by the structure of the leaf canopy and leaf area index (ILD). Utilization of radiation will take place optimally if the ILD value is 10.

Fartis and Curtis (2017) suggest the importance of choosing plant material with a vertical canopy structure because it is efficient in using solar radiation compared to a flat canopy structure. Observations made on pine and mixed forest vegetation show that in a dense canopy structure conditions can absorb more sunlight.

Density regulation (planting density) is also a policy implemented by the management. At the beginning of the conversion, which was 1996 using an equilateral triangle planting system with a planting density of 124 trees / ha; However, by evaluating the occurrence of excessive vegetative growth (enlargement of the trunk), the areas converted in the 2004 and 2005 planting years were changed to a 10.5 m equilateral triangle (104 trees / ha) and 10.25 m (110 trees / ha). Turner and Girill Hanks (1982) suggest that spacing needs to adjust the characteristics of planting material, especially the length of the midrib, soil fertility and other factors including climatic conditions.

Listia et al (2015) reported the results of their research on differences in the growth of oil palm stems (age 8 years) planted at an altitude of 368 m asl and 865 m asl, respectively 3.71 m and 5.11 m (an increase of 37.7 m). %); and the stem volume was 2,770.2 l and 3,558.2 l (an increase of 28.4%).

The low air temperature has an impact on the late ripeness of the fruit, which takes 7 months compared to 6 months in standard conditions. Budwell et al (1979) suggested that at low temperatures the activity of

enzymes / hormones that play a role in the fruit ripening process, namely ethylene compounds, will experience obstacles. The fruit is not able to do respiration optimally so that the condition of the fruit is in a hard structure condition / has not experienced wilting. Listia et al (2016) suggest that the conditions for oil palm planting in high elevation areas result in low yield (oil extraction rate), namely 25.7% for oil palms planted at an altitude of 368 m asl and 23.5% in plantations located at an altitude of 865 m above sea level (decreased by 8.6%).

c. Productivity

In order to achieve the plant productivity target, the fertilizer application used is compound fertilizer with NPK 13.8.27.4 formulation; NPK 17.10.20 + 1TE and added with single fertilizer ZA, TSP and Dolomite with an average fertilizer dose of 8-9 kg / tree / year or 1040-1170 kg / ha / year which is applied 2x, namely in the first semester (April) and in the second semester (October)

The main emphasis of the selection of compound fertilizer formulations is selecting fertilizers with high K nutrient content which aims to improve turgidity, increase photosynthesis and also increase enzyme activity. Maschener (1988) argues that high-class plants including oil palm require large amounts of nutrients and one of the properties of the element K (K +) is mobile, so it requires an application with a higher frequency. Productivity data can be seen in Table 2.

Table 2.Productivity of Oil Palm Plants in Bah BirungUlu (tonnes of FFB / ha)

Age (years)	IOPRI Standard	Planting Years							
		2004		2005		2006		Average	
		Ton	%	Ton	%	Ton	%	Ton	%
3	7	0	0	2,01	28,7	6,70	95,7	4,36	62,2
4	12	9,35	77,9	16,16	134,7	7,00	58,3	10,84	90,3
5	14	16,23	115,9	17,67	126,2	14,09	100,6	16,00	114,3
6	17	20,84	122,6	19,23	113,1	17,67	103,9	19,25	113,2
7	22	23,13	105,1	17,75	80,7	16,26	73,9	19,05	86,6
8	25	21,57	86,3	17,51	70,0	22,85	91,4	20,64	82,6
9	26	20,70	79,6	21,14	81,3	22,69	87,3	21,51	82,7
10	26	22,57	86,8	22,58	86,8	20,83	80,1	21,99	84,6
11	26	23,16	89,1	22,74	87,5	24,26	93,3	23,39	89,9
12	26	23,42	90,1	24,98	96,1	25,05	96,3	24,48	94,2
13	25	28,24	113,0	23,95	95,8	25,75	103,0	25,98	103,9
14	24	27,23	113,5	25,86	107,8			26,55	110,6
15	24,5	31,29	127,7					31,29	127,7
Sum	**274,5**	**267,73**	**97,5**	**231,58**	**92,6**	**203,15**	**90,0**	**265,31**	**96,7**
Average	**21,1**	**20,59**	**97,5**	**19,30**	**92,6**	**18,47**	**90,0**	**20,41**	**96,7**

Information: Data until 2019

The crops planted in 2004 and 2005 experienced a delay in production and starting at the age of 4 the productivity increased. Meanwhile, for plants grown in 2006, normal productivity is in accordance with the standard of production potential. In general, the planning for planting oil palm in one economic cycle is 25-30 years. Keeping plants that die from various causes is a priority (Lubis, 2008). On average, the comparison between the productivity standards of PPKS and the realization of the achievements is shown in Figure 3.

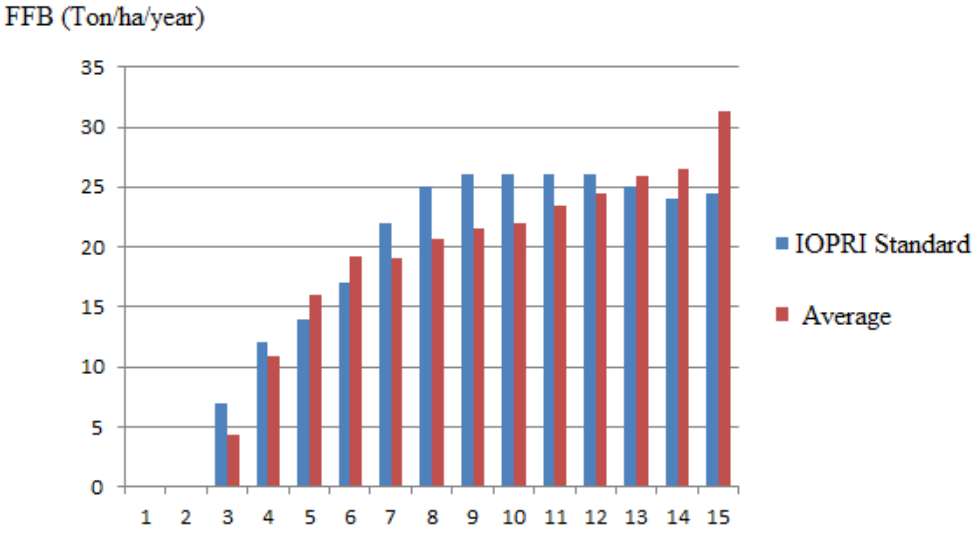

Figure 3. Palm oil productivity at Bah Birung Ulu

The lowest level of realization occurred in the 3rd year, namely 62.2% and subsequently continued to experience various ratings and in total it reached 96.7%. From this realization data provides a prospect that limiting factors for long exposure and low air temperature can be overcome by a good technical culture including the fulfillment of fertilizer needs.

IV. Conclusion

The conversion of land for ex-tea plants to plant oil palm in Bah BirungUlu has climate limiting factors, namely excess rainfall, high humidity and lack / low temperature and sunshine. The land is classified as S3 land (somewhat suitable) for oil palm plantations. The cultivation technique that is carried out is adjusted according to the spacing, and a good fertilization policy. Productivity data for the 2004, 2005 and 2006 planting years from 3-15 years of age varied in achievement, namely 62.2% -127.7% with average 20.41 ton FFB/ha and the total percentage of achievement was 96.7% compare to IOPRI standard.

References

[1]. Aguilera J, U. Karsten, H. Lippert, B. Vogele, E. Philipp, D. Hanelt and C. Wiencke. 1999. Effect of Solar Radiation on Growth, photosynthesis and respiration of marine macroalgae from the arctic. Marine Ecology Progress Series vol 191: 109-119.
[2]. Budwell, R.Ci.S, 1979. Plant Physiology. 2nd Editiori Collier Macmillan Canada Ltd.
[3]. Corley R.H.V; J.J. Hardon and L.J. Wood. 1987. Oil Palm research. Elsivier Scientific Publishing Company.
[4]. Ditjenbun 2018. Statistik Perkebunan di Indonesia KelapaSawit(Plantation Statistics in Indonesia Oil Palm). DepartemenPertanian RI.
[5]. Eden. T, 1976. Tea (3rd Edition). Longmans Group Ltd. London.
[6]. Hartley C.W.S. 1984. The Oil Palm Tropical Agriculture Series. 3th edition. The Plant House Ltd.
[7]. Jain, V.K. 1985. Fundamentals Of Plant Physiology. S. Chand & Company Ltd. New Delhi.
[8]. Listia E, D. Indradewa and E. Tarwaca. 2015. Growth, Productivity and Yield of Palm Oil in the Highlands. Journal of Agricultural Science Vol 18 (2): 77-83.
[9]. Lubis, A.U, 2008. Palm Oil (ElaeisguineensisJacq) in Indonesia. Oil Palm Research Center. Field.
[10]. Maschener, H. 1988. Mineral Nutrition of Higher Plants Second Edition. Academic Press.
[11]. Mearns, L.O, 2000. Climate change and variability. CAB International.
[12]. PT. Perkebunan Nusantara IV. 2015. At a Glance PTPN IV Bah BirungUlu Business Unit, P. Siantar, North Sumatra.
[13]. Siagian, R, 2013. 182 Years of Plantation in Indonesia (182 Tahun Perkebunan di Indonesia) 1830-2012. CempakaKencana Foundation. Yogyakarta.
[14]. Simangunsong, G, Taufik C.H and H.H Siregar, 2005. Oil Palm Production Trends in the Highlands (Trend Produksi Kelapa Sawit Di Dataran Tinggi. Warta PPKS Volume 13 (3) : 1-6). Warta PPKS Volume 13 (3): 1-6. Medan Palm Oil Research Center.
[15]. Susanto, A, Roletha Y.P and Agus E.P, 2010. Oil Palm Pests and Diseases (Hama dan Penyakit Kelapa Sawit). Oil Palm Research Center, Medan.
[16]. Susanto, ES, W. Darmosaskoro and Wirarna, 2003. Land and Oil Palm Fertilization (Lahan dan Pemupukan Kelapa Sawit). Oil Palm Research Center, Medan.
[17]. Turner, P.D and Grillbankes, RA, 1982. Oilpalm Cultivation and Management The Incorporated Society Of Planters Malaysia.
[18]. Usmul Safi Kartika, P. Marbun and P. Marpaung. 2016. Evaluation of Land Suitability for Arabica Coffee (Coffe Arabica) and Strawberries (Fragesiavesea Linn) in PematangSidamanik District, Simalungun Regency (EvaluasiKesesuaianLahanuntukTanaman Kopi Arabika (*Coffearabica*) danStrawberri (*Fragesiavesea*Linn) di KecamatanPematangSidamanikKabupatenSimalungun). Journal of Agroecotechnologyvol 4 (3) June 2016 (596): 2009 - 2020.
[19]. Wahyuni, M, 2017. The Productivity Of Plant Oil Palm (ElaeisguineensisJacq) On High Elevation Land Ex Tea (Camellia sinensis) Plantation at Bah BirungUluSimalungun North Sumatra Province-Indonesia. Proceeding Of Agriculture, Biotechnology and Sustainability PIPOC 2017 International Palm Oil Congress - Kuala Lumpur.

[20]. Woittiez LS, MT Wijie, M. Singerland, M. Noordwijk and K. E. Giller. 2017. Yield gaps in palm oil: A quantitative review of Contributing factors. European Journal of Agronomy vol 83: 57 - 77.
[21]. Xinshue L, F. Zi-hui and H. Pei-min. 2014. Effect of solar radiation on photosynthesis and pigmentation in the red algae Pyropiayezoensis Ueda (Bangiales, Rhodophyta) Indian Journal of Geo Marine Sciences vol 43 (4) April 2014, p 473-480.

MardianaWahyuni, et. al. "Solar Radiation Problem of Oil Palm Cultivation ElaeisguinensisJacq) On High Elevation Land Ex Tea (Camellia sinensis) Plantation At Simalungun, North Sumatera Province – Indonesia." *IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)*, 14(1), 2021, pp. 55-60.