The Performance of Oil Palm Productivity and Management of Organic Materials at Various Rain Intensity in Sandy Soil

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The Performance of Oil Palm Productivity and Management of Organic Materials at Various Rain Intensity in Sandy Soil

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Abstract. Climate anomalies marked by the presence of el Nino and la Nina need attention in managing oil palm plantations. These conditions have a bad influence on water conditions, especially in sandy land. The application of empty fruit bunches as organic matter source is expected to reduce the adverse effects of la Nina on palm oil production. This study aims to reveal variations of rainfall intensity and organic matter on the productivity of oil palm in sandy land. Results shows that the application of empty bunches accompanied by vegetation management is useful in maintaining the condition of the sand in holding water on one side and controlling excess water on the other side for 24 months (2011-2012). The application has succeeded in increasing production 23% higher than its potential yield in sandy soil with annual high rainfall (3,700 mm).

1. Introduction

Palm oil (*Elaeis guineensis* Jacq.) is the world's main vegetable oil-producing monocot plant. The area of oil palm plantations in Indonesia reaches 14 million hectares, the largest in the world and the exploitation of these commodities has a strategic role in sustainable oil palm plantation and regional development. Therefore, productivity is the main target in the exploitation of this commodity. Although this productivity fluctuates, mainly because of climate change which in the last decade has caused climate anomalies whose impacts are predicted to be even greater [1]. Drought is a condition produced by the interaction of reduced groundwater, low rainfall, and limited water availability [2].

Drought causes a decrease in the bunch and oil yield by 20% [3]. Dry season can affect sex ratio, reducing the number of FFB. Changing rainfall patterns posed problems for long-term oil palm plantations, especially especially longer dry period. Meanwhile, irrigation is difficult to apply in oil palm plantations because of its large area of [4]. Palm oil requires 4-5 mm of water per day (equivalent to 12 liters per tree per day) and requires rainfall of 1,800-2,000 mm per year to obtain optimum production. The production of this plant decreases by 10% for every reduction of 100 mm of water due to reduced rainfall of [5], so that long periods of drought can drastically reduce productivity. On the other hand, high rainfall during the La Nina period had almost the same effect on palm oil production. This influence is related to irradiation, nutrient washing, inundation and regeneration of oil palm roots.

The availability of water for oil palm depends on rainfall and soil properties. Sandy soils have the nature of chirping with low levels of soil aggregation resulting in low water-holding ability and low oil

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palm production. Improvement of soil aggregation is a top priority in the management of the land which is carried out with the application of soil enhancers. Empty bunches are by-products of palm oil mills which are difficult to degrade [6], and require about 90 days to degrade. Empty bunches account for 28.5% of fresh fruit bunches [7]. The use of empty bunches as organic matter source and nutrient substitutes in oil palm plantations has been reported [8, 9]. However, its role as a soil remover material is still limited and has not been studied in-depth, especially in sandy lands during high rainfall as has happened due to climate change. This study presents the performance analysis of the use of empty bunches as an effort to reduce the adverse condition of climate (high rainfall) on oil palm oil yield.

2. Research Method

Research was conducted at 2,552 ha plantation area, divided into three divisions, 78 blocks (one block = 30 ha), with sandy soil (spodosol). Application of empty fruit bunches annually of 40 ton/ha/year, and N. *biserrata* understory vegetation were planted at a medium density of 3-5 plants/m^2. Rainfall and yield are observed for 24 months (2011-2012). The effect of rainfall on oil palm yield is revealed by analysis of variance and the relationship between rainfall and production is determined by regression analysis and correlation with the model $Y = c + \beta \log X$.

3. Result and Discussion

Climatic conditions in the location of oil palm plantations for 24 months (2011-2012) of observation showed high rainfall with an almost even distribution, although during 2011 there were two dry months. Rainfall in this time period exceeds the ideal range for the feasibility of oil palm cultivation. Ideal rainfall is around 1,700-2,500 mm per year with a dry month of no more than two months [10]

Table 1. Climatic Condition during Two Years

Year	Rainfall Intensity (mm/year)	Number of Rainy Days (day/year)	Number of Dry Months
2011	3,688	154	2
2012	3,799	153	0

High rainfall over the past 24 months and a few years before (2009-2010) can have a major effect on palm oil production, as shown in Table 2. These climatic conditions affect the vegetative and generative growth rates of trees that are closely related to fitomer development (one part with one interest) and sex determination, and pollination/fertilization and the weight of the bunch to be harvested.

Table 2. Oil Palm Production in Spodosol Soil

Plant Age	Potential Yield			Actual Yield			Yield Gap (%)		
	Fruit Bunch Weight (kg/bunch)	Fruit Bunch Number	Bunch Yield (ton/ha/year)	Fruit Bunch Weight (kg/bunch)	Fruit Bunch Number	Bunch Yield (ton/ha/year)	Fruit Bunch Weight (kg/bunch)	Fruit Bunch Number	Bunch Yield (ton/ha/ year)
7	10.00	15.70	22.00	9.81	14,49	18.57	- 1.89	- 7.72	- 15.61
8	12.70	14.80	24.50	11.57	20.26	30.15	- 8.92	36.90	23.00

There is a gap in oil palm yield during the two years of observation. Bunch yield increasing in 2011 is still below its potential. This is related to the high rainfall during the previous year (2010) which exceeded 5,000 mm. High rainfall results in a yield gap of -15.61% which is an indirect effect of weight and a lower number of fruit bunches.

On the other hand, palm oil production in 2012 exceeded its production potential (23.00% above its production potential). The number of harvested bunches increased by 36.90% while the weight of the fruit bunches decreased by 8.92%. Fruit bunch weight reduction is caused by fruit set and/or fruit weight is low. High rainfall causes pollen leached and pollinator insect activity is low so that the value of fruit bunches is low. Whereas the small-sized fruit due to the limited supply of photosynthate due to short exposure duration due to high rainfall. The number of fruit bunches has increased sharply due to the excess owned by the sandy soil which is able to reduce excess water due to high rainfall during the previous 14-18 months. The bad influence of high rainfall can be minimized by the nature of sand removal, this condition encourages the emergence of female flowers. Excessive rainfall results in disruption of root respiration which inhibits nutrient uptake and causes faster root senescence, if soil drainage is poor [11].

The results of the study revealed that the estate block did not interact with the weight and number of fresh fruit bunches and total yield (Figure 1-3). This indicated that the application of empty fruit bunches in the three blocks has been able to maintain groundwater content in a suitable range so that fluctuations in monthly rainfall for 24 months did not have a significant effect on the fruit bunches yield.

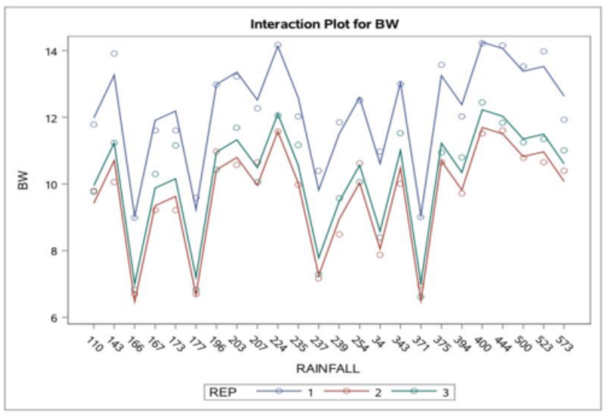

Figure 1. Fluctuation of Rainfall and Oil Palm Bunches Weight

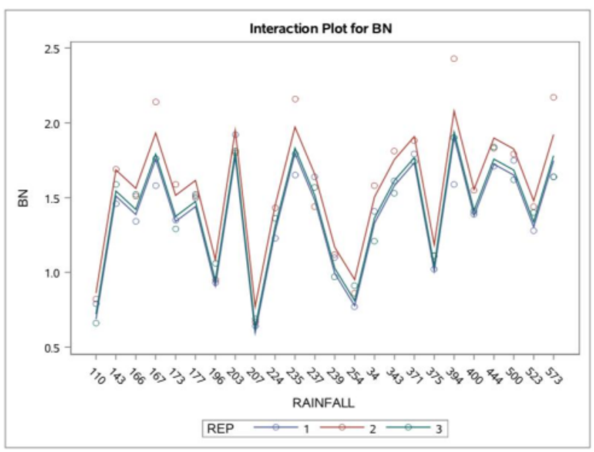

Figure 2. Fluctuation of Rainfall and Oil Palm Bunches Number

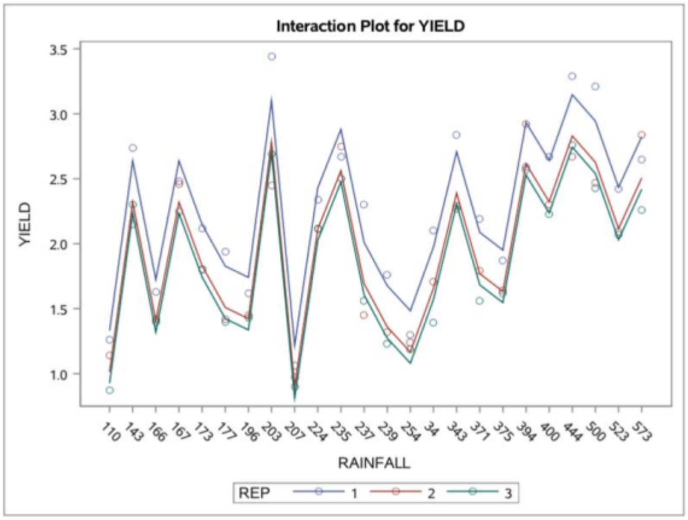

Figure 3. Fluctuation of Rainfall and Oil Palm Bunches Production

Analysis of regression shows that rainfall intensity had a close relationship with palm oil production (Table 3). Although rainfall is high and almost evenly distributed throughout the year, its negative influence on palm oil production can be reduced by the physical properties of sandy soils that have good drainage properties. The application of empty bunches and vegetation management can improve the porosity of the sand so that it can maintain groundwater in the absence of rain.

Table 3. Rainfall Relationship and Oil Palm Yield in Spodosol Soil

Oil Palm Yield Component	Regression Model	p .05
Fruit bunch weight	Y = 9.489 + 0.004 X	Close
Fruit bunch number	Y = 1.187 + 0.001 X	Close
Bunch Yield	Y = 1.454 + 0.002 X	Close

Management of organic material sources through the application of empty oil palm bunches and understorey vegetation can reduce the adverse effects of climate on oil palm yields on sandy soils. According to previous workers, the increasing nutrient uptake applied to sandy soils becomes a priority in fertilizer management to eliminate nutrients carried in harvested bunches, pruned frond and nutrient leaching [11].

4. Conclusion

Palm oil yield was determined by the weight and number fresh fruit bunch. Rainfall evenly distributed which have a close relationship with these two yield components on spodosol soils. However, its adverse effects can be reduced in different ways depending on the condition of high rainfall during the reproductive cycle (generative cycle) and the growth of oil palm fresh fruit bunches, the application of empty bunches and understory vegetation management on spodosol soil during high rainfall conditions plays a role in maintaining soil conditions for oil palm growth and it can increase production by 23%, bunches 36.9% but bunch weight decrease 8.92% compared to its potential yield.

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