EFFECT OF CUTTING INTERVAL ON DRY MATTER YIELD AND BOTANICAL COMPOSITION OF COVER CROPS UNDER THE OIL PALM PLANTATION

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Abstract

The increasing area of oil palm plantation in the Province of Jambi, especially at Batanghari Regency, Indonesia offers an opportunity for integrating oil palm with livestock production systems. Cover crops for erosion control and weed suppression can also be utilized as fodder sources, since leguminous species such as *Pueraria javanica* and C*entrosema pubescens* are generally sown under the palm trees. However, with increasing age of oil palms light penetration to the ground will be reduced. Therefore, appropriate cutting management should be evaluated in order to obtain the optimum forage yield. Cutting cover crops at different stages will influence the growth of above ground biomass and the botanical composition of cover crops species.

Sixteen single-tree-plots of oil palm that were about three years old and were arranged as 2 factorial randomized complete block design with four replicates. The first factor was stratum (shade and sun), the second was cutting interval: 30, 60, 90 and 180 days after the initial trimming. The latter was the control.

Dry matter production showed strong response to cutting interval as well as stratum, but no interaction was found. A cutting interval of 30 days was the best cutting interval in terms of dry matter production of cover crops. The yield was double as compared to the control. Dry matter production in the shade was lower than in the sun. It obtained only 42 % of total dry matter production. The botanical composition assessment revealed that cutting interval affected the botanical composition of cover crops. With increasing cutting frequency the abundance of grass species increased as compared to legume and weed species. The cover crop vegetation under 30-day cutting interval was dominated by grass species that are resistant to frequent cutting such as *Axonopus compressus, Digitaria cilliaris, Ottochloa nodosa* and *Paspalum dilatatum.*

Keywords: cutting interval, dry matter yield, botanical composition, cover crop, integrated oil palm livestock system

Introduction

The Province of Jambi is one of the region which is directed towards plantation commodity development. This policy of regional development (Indonesia) is supported by the availability of land as the total land area in Jambi Province is about 5,100,000 ha. Most of the plantation production is devoted to export commodities such as rubber, coffee, coconut and cocoa. Oil palm has good prospects in Jambi Province (Plantation Service of Jambi Province, 1999). In connection with the development of Jambi Province, the Regional Government promotes an integrated system of agriculture (plantation and livestock production ~ silvopastoral system), especially on oil palm plantations which have become the most important commodity in Jambi, recently. This is also a good solution providing small holder farmers with land for growing good quality of fodder crop since the land is limited. Apart from this, the regional government has declared the “**Opening a million hectares of oil palm plantation**” program. The projected production area of oil palm plantations in Jambi Province by the year 2003 is 318,800 ha with a growth rate of 6.7%, while for Batanghari Regency; it is 111,100 ha within these 318,000 ha, with a growth rate of 14% (Central Bureau of Statistics of Jambi Province, 1999).

Plantation are establised by using heavy equipment and chemical substances for removing the debris (weeds). This will lead to physical and chemical degradation of the topsoil if it is not protected. Therefore to reduce soil erosion and suppress the noxious weeds, cover crops such as *Pueraria javanica* and C*entrosema pubescens* are sown under the palm trees. Cover crops are either pure stands of legume or mixtures of legume and grass species. These mixtures of forage offer great opportunity for establishing mixed farming systems by integrating livestock (particularly ruminants) into plantation farming. The herbage of the cover crops could be used partially as forage for livestock both from quality and quantity. The main problem related to environmental conditions is that with the increasing age of oil palms, the quantity of forage decreases. This is due to the increasing crown size of oil palms which reduces the share of photosynthetic active radiation that can be intercepted by the cover crop. This will reduce photosynthesis rates of the cover crops. In the end it will reduce their biomass yield. Therefore, appropriate cutting management should be evaluated in order to obtain the optimum forage yield, because cutting cover crops at the right stages will influence the growth of above-ground biomass and the botanical composition of cover crop species. The species with a good ability to recover from defoliation and adaptation to shady conditions will be more dominant.

Materials and Methods

The experiment was conducted in a representative oil palm plantation located in the area called Sei. Duren District. This oil palm plantation belongs to PTP. Nusantara VI, a state-own plantation company. During the experimental period, the mean monthly maximum temperature ranged from 30.0°C – 31.9°C and minimum temperature 22.8°C – 23.3°C, with relative humidity around 88% (Metereological and Geophysical Station of Sei. Duren, Jambi Province, 2001). The average rainfall ranged from 1900 to 3200 mm per annum (Central Bureau of Statistic of Jambi Province, 1999).

The oil palms were planted in soil pits 60cm deep and 60cm wide at the age of 18 months. The spacing of oil palms was 9m x 9m. Before planting, 0.5kg of rock phosphate fertilizer was filled in at the bottom of the soil pit. When the experiment started, the age of oil palms was 3 years; i.e. in the stage of a young palm (not productive yet). The height of oil palm was around 308cm. The cover crops were sown in April 2000 so that the age of cover crops was 6 months old at the begin of the experiment. The sown cover crops consisted of *Pueraria javanica* and *Centrosema pubescens*. Both were sown by dibbling the seed together with fertilizer at a ratio 6:4:10 (6kg *Pueraria javanica*, 4kg *Centrosema pubescens* and 10kg of rock phosphate fertilizer with 31 – 33% P_2O_5 content) per hectare. Two rows of *Pueraria javanica* anda row of *Centrosema pubescens* were sown between a row of oil palms at a spacing of 30cm with 4 – 5 seeds per hole. After planting the oil palms, weed-free circles were formed by hand hoeing. The initial diameter of the weed-free circle was 1.5m but increased as the procedures followed the growth of the crown size.

During the experimental period, in January 2001, the company enlarged the diameter of the weed-free circle area. The oil palms were fertilized around the weed-free circle area in December 2000 with 0.5kg of urea, 1.0kg of rock phosphate, 0.5kg of muriate of potash and 0.5kg of kieserite per tree. In March 2001, the oil palms were fertilized with 0.5kg of urea, 0.75kg muriate of potash, 0.5kg of kieserite and 0.5kg of borate.The fertilization was done using the broadcast method. When fertilizing the weed-free circle, the shade stratum was also affected. It was predicted that fertilizing would also affect the strata 1 (shade area) environment.

Sixteen single-tree-plots of oil palm that were about three years old and were arranged as 2 factorial randomized complete block design with four replicates. The first factor was stratum (shade and sun), the second was cutting interval: 30, 60, 90 and 180 days after the initial trimming. The latter was the control.

The variables observed in this study were dry matter yield and botanical composition of the cover crops. Dry matter yield from forage cover crops was obtained after each harvest. The fresh samples were dried at 70^0C for 72 hours until constant weight was achieved. OHAUS (Harvard trip balance) was used with 2kg scales. The dry matter content was multiplied by the yield from every harvest and then converted to kg/ha. Botanical composition was evaluated by using a square frame of 0.5m x 0.5m placed randomly within each stratum at every harvest according to the interval of cutting. In this assessment, the forage cover crops were divided into three fractions: legumes, grasses and weeds and put into three ranks (rank 1, rank 2 and rank 3) based on an estimated dry matter yield production from the highest to the lowest. Then the three ranks were multiplied by a coefficient factor of 8.04, 2.42 and 1, respectively (Mannetje and Haydock, 1963).

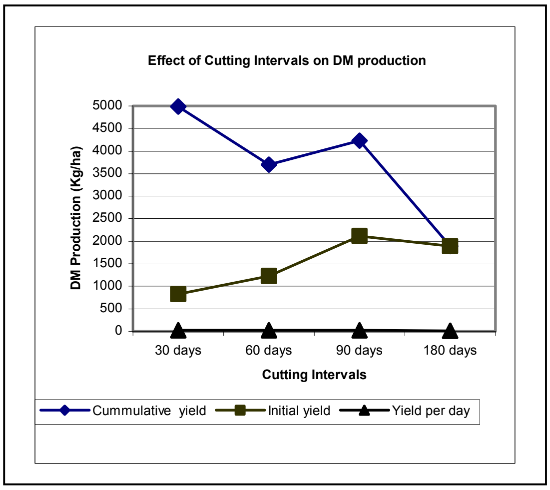
The analyses of variance were performed by using the General Linear Model of Systat package available at the Faculty of Agricultural Science, Georg-August University in Göttingen. Treatment means were compared by using Fisher's Least-Significant-Difference (Fisher's LSD) Test.

Result and Discussion

The cumulative, initial dry matter and yield per day over the six-month experimental period was significantly ($P<0.05$) affected by cutting interval and stratum. However, the interaction between cutting interval and stratum was not significant ($P>0.05$).

A cutting interval of 30 days obtained the highest cumulative dry matter yield, and the lowest cumulative dry matter yield was at the cutting interval of 180 days. Cutting every 30 days obtained double the amount of cumulative dry matter yield from cutting interval of 180 days while the cutting intervals of 60 and of 90 days showed no significantly greater yield. Frequent cutting caused more leaf regrowth and more tillers appeared. Cutting management opened the area up to sunlight and it possibly stimulated growth of the sward and seed weeds. Trung *et al* (1991) reported that dry matter yield per annum of native pastures under coconuts was higher with shorter cutting intervals. This is supported by Humphreys (1987) who stated that defoliation increased the light intensity in the lower level of the sward. This may stimulate the germination of some light-responsive seed weeds. On the other hand, Hodgson (1991) reported that the growth of new tillers may be triggered off by defoliation of the plant.

In contrast, the cutting interval of 180 days obtained the lowest cumulative dry matter yield in this study. The light could not reach the ground because of the dense leaf cover. There was competition between the plants: the taller plants blocked the light from the shorter plants. The longer interval of cutting led to much senescence and dead material falling to the ground. This probably explains the lowest yield obtained by the cutting interval of 180 days. For instance, as explained by Hodgson (1991), individual tillers have a limited life span, from vegetative to reproductive growth. When the plant reaches the fully vegetative growth phase, the vegetative growth will stop and generative growth continues. At this stage, the development of any young tiller is blocked until the productive stem is cut off or dies. Humphreys (1991) stated that net growth of pasture is described as the balance between increase in shoot tissue and the losses caused by senescence and the detachment of shoot tissue.



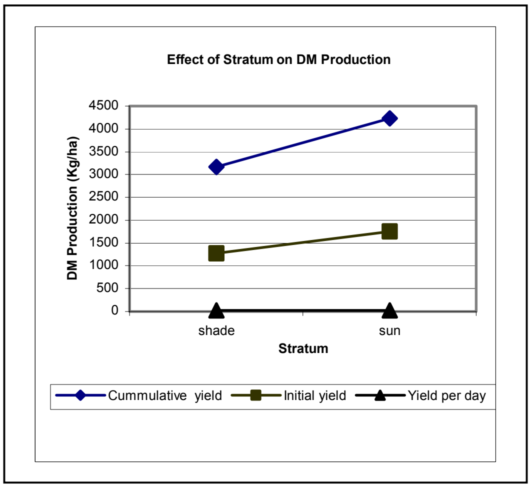


Figure. Effect of Cutting Interval and Stratum on Dry Matter Yield of Cover Crops under the Oil Palm Plantation

Just as it affected the cumulative dry matter yield, cutting interval also showed an effect on initial dry matter. A cutting interval of 30 days obtained the lowest dry matter yield compared to cutting intervals of 90 and 180 days. As a single cutting, cutting every 30 days produced less dry matter yield compared with other cutting intervals. With this interval, the plant had little time to accumulate the dry matter compared with the other longer cutting intervals. As Wade and Carnalho (2000) reported the shorter the period between defoliation, the greater the reduction in quantity harvested. Trung *et al* (1991) found that dry matter yield was higher during the wet season with longer cutting intervals. This is supported by Humphreys (1991) who stated that yield increases with an increasing duration of the growth period between cuts.

The shade stratum obtained lower dry matter yield than sun stratum where as shade stratum produced only around 42% of total dry matter production. During the six-month experimental period the oil palm company enlarged the weed-free circle once. Therefore, some areas of cover crops were pulled up. For further growth, the cover crops grew from the remained roots and stolons. This might be also the causes of decreasing dry matter yield in the shade stratum. On the other hand, the decreasing yield on the shade stratum might be that it really causes a reduction in light. As Humphreys (1991) stated, pasture growth is limited by the amount of light intercepted by the green surface of the sward. This is supported by a report from Norton *et al* (1991) that herbage yield was initially depressed by shade.

The botanical composition assessment indicated that cutting interval affected the botanical composition in terms of species changes and percentage of botanical composition fractions (Tabel 1). Cutting interval at 180 days as control showed not many species presented at the two stratum. It was considered that cutting interval of 180 days as the original species before cutting treatments were started. With longer periods of cutting, the plant develops fully. The vigorous taller plant formed a dense cover. It prevented the light from penetrating to the ground. Under these condition, there was competition between the plants to get the light. At the end, only the taller and resistance plant that had rapid growth and shade-tolerant plant keep survive in this environment. As Humphreys (1991) stated that botanical composition is controlled by grazing or cutting and the processes of individual plant persistence and replacement. This means that only the most persistent plant survive, replacing older plant and these plant are capable of interfering with the environment of neighbouring plant.

Table 1. Effect of cutting interval and stratum on botanical composition of cover crops under the oil palm plantation at Sei. Duren, Batanghari Regency during the six-month experimental period.

Stratum	Cutting interval (days)			
	30	60	90	180
Shade	**Sown species (legumes)** *Pueraria javanica* *Centrosema pubescens* **Spontaneous species** **Grasses** *Axonopus compressus* *Cyperus kyllingia* *Digitaria ciliaris* Unidentified species *Imperata cylindrica* *Ottochloa nodosa* *Paspalum conjugatum* **Broad-leaved weeds** *Ageratum conyzoides* *Borreria sp* *Crassocephalum crepidioides* *Ipoemea triloba* *Mikania micrantha* *Mollugo penthaphylla. L* *Phylanthus sp*	**Sown species (legumes)** *Pueraria javanica* *Centrosema pubescens* **Spontaneous species** **Grasses** *Axonopus compressus* *Digitaria ciliaris* Unidentified species *Ottochloa nodosa* *Paspalum conjugatum* **Broad-leaved weeds** *Ageratum conyzoides* *Borreria sp* *Crassocephalum crepidioides* *Ipoemea triloba* *Mikania micrantha*	**Sown species (legumes)** *Pueraria javanica* *Centrosema pubescens* **Spontaneous species** **Grasses** *Ottochloa nodosa* Unidentified species **Broad-leaved weeds** *Ageratum conyzoides* *Borreria sp* *Crassocephalum crepidioides* *Ipoemea triloba* *Mikania micrantha*	**Sown species (legumes)** *Pueraria javanica* *Centrosema pubescens* **Spontaneous species** **Grasses** Unidentified species **Broad-leaved weeds** *Ageratum conyzoides* *Borreria sp* *Crassocephalum crepidioides* *Ipoemea triloba* *Mikania micrantha*
Sun	**Sown species (legumes)** *Pueraria javanica* *Centrosema pubescens* **Spontaneous species** **Grasses** *Digitiria ciliaris* *Imperata cylindrica* Unidentified species *Ottochloa nodosa* *Paspalum conjugatum* **Broad-leaved weeds** *Ageratum conyzoides* *Borreria sp* *Crassocephalum crepidioides* *Ipoemea triloba* *Mikania micrantha*	**Sown species (legumes)** *Pueraria javanica* *Centrosema pubescens* **Spontaneous species** **Grasses** *Axonopus compressus* *Digitiria ciliaris* Unidentified species *Ottochloa nodosa* **Broad-leaved weeds** *Ageratum conyzoides* *Borreria sp* *Crassocephalum crepidioides* *Ipoemea triloba* *Mikania micrantha* *Stacystapheta jamaencis*	**Sown species (legumes)** *Pueraria javanica* **Spontaneous species** **Grasses** *Ottochloa nodosa* **Broad-leaved weeds** *Ageratum conyzoides* *Borreria sp* *Mikania micrantha* *Stacystapheta jamaencis*	**Sown species (legumes)** *Pueraria javanica* *Centrosema pubescens* **Spontaneous species** **Grasses** Unidentified species *Ottochloa nodosa* **Broad-leaved weeds** *Borreria sp* *Ipoemea triloba* *Mikania micrantha*

The 30-day cutting interval had the highest percentage of grasses fraction (Tabel 2). And there was less species present after longer period of cutting, for instance, cutting interval of 90 and of 180 days. The cutting opened up the area which would otherwise be intercepted by the cover crops. It might stimulated the germination of seed existing in the ground. It might be possible that there was seed bank in the soil as the land plantation was from the rubber estate conversion. Humphreys (1987) stated that defoliation will also increase the light intensity in the lower level of sward and this may stimulate the germination of some light-sensitive weed seeds. For instance, Mannetje and Jones (1992) reported that some grasses species were found in the botanical composition which were tolerant to the close cutting interval such as *Axonopus compressus, Digitaria ciliaris, Ottochloa nodosa and Paspalum conjugatum*.

Table 2. Effect of cutting interval and stratum on percentage of botanical fraction of cover crops under the oil palm plantation at Sei. Duren, Batanghari Regency based on Dry Weight Rank method.

Botanical fraction	Stratum	Cutting interval (days)			
		30	60	90	180
			(%)		
Legumes	Shade	14.7	12.0	15.2	13.8
	Sun	17.9	16.4	30.5	25.9
Grasses	Shade	46.4	45.1	25.0	30.2
	Sun	55.9	47.1	31.0	27.3
Weeds	Shade	39.9	42.9	59.8	56.0
	Sun	26.2	36.5	38.5	46.8

Conclusion

A cutting interval of 30 days was the best cutting stage in terms of dry matter yield of forage cover crops. The yield was doubled that of the control. Shade stratum obtained only 42 % of total dry matter production. The botanical composition assessment recorded that cutting interval affected the botanical composition in terms of species changes and percentage of botanical composition. And the frequent cutting resulted in more grass percentage than infrequent cutting.

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