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Research Paper

EFFECT OF CUTTING INTERVAL AND CUTTING METHODS ON *Adenanthera pavonina* L. ANNUAL FORAGE YIELD

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Abstract

An experiment was conducted to study the growth and the effect of cutting intervals and cutting methods on Adenanthera pavonina L. annual forage yield. The growth was observed every three months until 24 months. The average plant height at 6, 12, 18, and 24 months after planting were 77.30±13.21, 133.73±31.07, 204.05±40.98, and 280.87±54.85 cm, entering linear growth phase. At the same time, the average number of leaves per plant were 11.40±3.99, 19.78±18.69, 40.85±64.62, and 61.20±99.87 leaves and diameter of stem were 1.12±0.29, 2.56±0.44 3.94±0.78, and 5.26±0.96 cm still in initial growth phase. The experiment laid out based on Nested Randomized Block Design, the three cutting methods (1 m, 1.5 m cutting height, and 50 cm branches tip cutting) were nested on two cutting interval (3 and 4 months). An initial uniformity cutting was done based on cutting methods randomized before. Forage regrowth were harvested based on the treatments. Annual dry matter, organic matter, and crude protein forage yield were 2.11, 1.96 and 0.343 kg/tree or 21.1, 19.6, and 3.43 t/ha at 3-months cutting interval, significantly higher than 1.82 kg/tree or 1.82, 1.66, and 0.279 kg/tree or 18.2, 16.6, and 2.79 t/ha at 4-months cutting interval. There was no significantly difference between cutting methods, but the branches tip cutting and 3-months cutting interval tend to be the best with DM, OM and CP annual yield were.

Key words: *Adenanthera pavonina* L., growth pattern, forage yield, cutting methods, cutting frequency.

INTRODUCTION

Tree legumes are multipurpose crops that are easily integrated into existing farming systems by maintaining soil fertility and providing high protein animal feed. The existence of legume trees in the agricultural system offers many benefits without high capital [1]. They had high contribution in crop and livestock production. They provide fodder to animals and replenish soil fertility. *Adenanthera pavonina* L. is a tree legumes

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that had multiple uses and potentials. This plants produce useful product. It is a good fuelwood and yields very good charcoal. As a timber, the wood is very hard, durable and strong, resisteant to dry wood termites, can be used for bridge and household construction, and suitable for furniture and cabinet. It also provide services as shade or shelter. It is considered to be nitrogen fixing with sparse fast-growing, brown nodules, also has a Vesicular Arbuscula Mycorrizae on the roots, can be a soil improver with good green manure, and its compatibility with most tropical field and treecrops, making it suitable to used in integrated production system [2,3,4].

Nutritionally, it has great potential as a supplemental source of fodder, the forage are fairly high in digestible crude protein [2,5]. Trees had heavy branching and leavy. Initially growth is low, but after the first year increases rapidly with average annual growth rates attaining 2.3-2.6 cm in diameter and 2-2.3 m in height. It has good capability to resprout easily after cutting, allowing for coppice management with good survival [2]. Reports about forages yield were not widely available yet. According [6] total biomass production of saga trees aged 15 years can reach 289.1 kg fresh, 178.0 kg DM and water content of 48.9%, while leaf production reaches 25.0 kg fresh, 9.9 kg DM with a water content of 50.1%, the second highest 12 species of trees studied.

Limited information that scientifically reported, especially about the growth, potential yield of *Adenanthera pavonina* L. forage as suplemental source affected by cutting management attracted to conduct this study. The objectives of this study were to know the growth pattern and the effects of cutting intervals and cutting methods on *Adenanthera pavonina* L. forage yield.

MATERIALS AND METHODS

The experiment was conducted from September 2013 to January 2017 at farmer's farm in Talang village, Saronggi sub-district, Sumenep district, East Java, Indonesia with coordinates $07^0$04'58.0" South latitude, $113^0$49'43.1" East longitudes, and altitude at 54 m above sea levels. The soil of the experimental site was clay soil with a very low in total nitrogen (0.7 g kg^{-1}) and phosphorus (18.33 mg kg^{-1}), low in potassium content (160.9 me $100g^{-1}$), low in magnesium, very high in calcium, low in organic C content (0.74%) and neutral (7.00) in pH (Table 1). Rainfall was observed at climate station

approximately one kilometer from experimental site. The site was a dry area, with low rainfall (the average of annual rainfall for 5 year was 882.4 mm/tahun). There was no rainfall at the first 2 months after planting, and 260 mm for 2 months later in 2013, 821 mm in 2014, 381 mm in 2015, and 1139 mm in 2016.

The 120 potted seedlings in 30-40 cm height bought from nurseries managed by farmers, and planted at a 1 m x 1 m spacing after carefully removing the polythene bags. Before planting, 200 g manure was put in every planting hole. Watering was done in the first 3 month before rainy season and weeding was done as needed in the first year establishment. Growth variables (plant height, number of leaves and stem diameter) were observed every 3 month.

The experiment laid out based on Nested Randomized Block Design. The treatments were : cutting methods (1 m and 1.5 m cutting height, 50 cm branches tip cutting) and cutting intervals (3-months and 4-months). The 60 non-border plant with (average $\pm$standart deviation) were (280.87$\pm$54.85 cm) were divide into 10 block, as replication, based on site and plant height (Table 2).

When attaining a height of 2 m at 24 months after planting, an initial uniformity cut were done based on cutting methods randomized before. The next cutting were done based on combination treatments. The total fresh forage was directly weighed in the field after separated into edible (leafy branch or 0.5 cm maximum diameter branch) and non-edible (non-leafy or over 0.5 cm diameter branches) part for all the treatments. The 0.5 – 1 kg samples of edible part were taken to the laboratory, oven dried at 60^0 C for 48 h and later ground to pass through a 1 mm sieve prior to chemical analysis. The sample was oven-dried at 105^0C for 4 hours for DM analysis. Dry matter content was 60^0C oven-dried DM content times 105^0C oven-dried DM content. Total ash and CP content were analyzed according to standard methods of AOAC [7]. Organic matter content was the difference between DM with total ash content.

Statistical analysis were performed using Microsoft Excel version 2013. Exponential corellation and regression analysis was used to detemine the relationship between the months after planting (x) with plant height or number of leaves or stem diameter (y). A Nested Randomized Block Design was used for the analysis of the following variables :

annual DM, OM and CP forage yields. If there is a significant effect of the treatment, means were separated by Duncan's Multiple Ranges Test (DMRT).

RESULTS AND DISCUSSION

Growth pattern

Growth is an increase in the number and size of plant cells, which then differentiate to form tissues and organs, including roots, stems and leaves, so observing plant growth can be done by observing an increase in the number and size of each of these organs.

Plant height, number of leaves and diameter of stem growth rates of *Adenanthera pavonina* L. has a very high diversity as indicated by the high standard deviation. Standard deviation of plant height is 17.09-27.86%, leaf number is 18.72-163.22% and diameter of stem was 28.46-37.5% of the means value (Table 3). The diversity of plant visual performance is a manifestation of genetic diversity. *Adenanthera pavonina* L. as self-pollinating plants that grow naturally is very likely to have high genetic diversity. It could be high opportunity for plant breeding.

The means of plant height at 6 and 12 months after planting were 77.30±13.21 and 133.73 ± 31.07 cm, were better than the results of [8], that plant height at 2, 4, 6, and 12 months after planting were 13.98, 45.06, 64.92, and 99.96 cm respectively.

Annual plant height and diameter of stems growth rates from 12 to 24 months after planting in this study, namely 0.89-2.32 m and 2.2-3.11 cm, were higher than the observations of [2], that growth increased rapidly after 12 months after planting with an average annual growth rate of plant height of 2-2.3 m and a diameter of 2.3-2.6 cm in American Samoa. A diameter of 11 cm can be reached in 5 years.

Plant height, number of leaves and diameter of stem growth pattern of *Adenanthera pavonina* L. are following the exponential equation. In the exponential growth pattern, there are three phase of growth, the initial phase is a slow growth rate or exponential phase, and then a fast growth or linear growth until the turning point as the second phase, and the third phase is a decreasing growth rate. The growth of plant height (Figure 1) show that the initial slow growing phase was done until at 12 months after planting and start to fast growing phase This is in accordance with the opinion of [2], that the initial growth of saga tree plants was slow, but increased rapidly 12 months

after planting. Meanwhile, the growth of number of leaves (Figure 2) and diameter of stem (Figure 3) still in initial slow growing phase. In general, the growth pattern of *Adenanthera pavonina* L. follows a slow growth curve until the plants are 1-2 years old, fast growth up to 12 years old, followed by a decreasing growth rate as one of the 4 growing curves of *Picea mariana* Mill tree (9).

Forage yield

Effect of cutting interval on annual DM, OM and CP yield of *Adenanthera pavonina* L forage was very highly significance ($P<0.01$). The annual DM, OM and CP forage yield of the 3-months cutting intervals were very significantly higher than the 4-months cutting intervals ones (Table 4).

Annual forage yield is the accumulation of each cutting forage yield for a year. A tree forage legume species has a specific after cut regrowth pattern that would determine how long every growth phase done. It is important to determine the turning point, a point of maximum growth rate in regrowth pattern. Annual forage yield is the accumulation of each cutting forage yield for a year. It is important to determine the turning point, a point of maximum growth rate in regrowth pattern. According to [10], maximum forage production (leaves and branch tips less than 5 mm in diameter) occurs only a moments after maximum point of the growth rate, which is commonly used as an indicator to determine the optimum cutting interval. In *Calliandra calothyrsus,* the maximum forage growth rate occurs for 3 weeks, which is around 8.5 to 11.5 weeks. It was suggested that in *Adenanthera pavonina* L., the maximum forage growth rate occurs more slowly, presumably starting before 3 months of regrowth so that the 3 months-cutting interval result a maximum annual forage yield. The increasing cutting interval from 3-months to 4-months did not significantly increase forage yield per cuts because it has passed the maximum growth rate phase and has entered a declining growth rate phase. It caused a decreasing annual DM, OM and CP forage yield by 13.71, 14.19 and 17.54% respectively.

Similar result had been reported by [11] that forage and N yield of *Leucaena leucocephala* (Lam) De Wit increase up to more than 2 times at 3-month cutting intervals compared to 1-month cutting intervals. In *Gliricidia sepium* (Jacq.) Walp. that cut every 6 months yields the best forage production of 0.73 kg/tree/year compared

with that cut every 2 or 12 months [12]. The results of [13] research on *Desmanthus virgatus* which were cut as high as 50 cm produced 1376 kg/ha at 30-day cutting intervals, increase to 2405 kg/ha at 40-day and 2844 kg/ha at 50-day cutting intervals. *Indigofera* produces increasing DM shoot tip by delaying cutting from 38 days to 68 and then decrease at 88 days [14].

The results of studies conducted by [15] on *Moringa oleifera* showed that forage yield increased from 243.33 g/tree to 319.53 g/tree with increasing cutting intervals from 2, 4, 6, 8, 10 , and 12 weeks, and no significant difference between 6, 8. 10 and 12 week cutting intervals. A research of [16] on the same plant in the tropical forest climate regions of Nigeria, showed that by 4, 5, 6, and 12 weeks cutting interval obtained DM forage yield of 2.96, 2.88, 3.68 and 1.46 tons/ha in the rainy season and 0.27, 0.21, 0.26 and 1.09 tons/ha in the dry season.

There was no significant ($P>0.05$) effect of cutting methods on annual DM, OM and CP of *A. pavonina* L forage yield. In general, the cutting interval or cutting frequency has a more dominant influence compared to the method, the intensity or the cutting height on annual forage yield [10]. Cutting height is not a major influence on the nutritional characteristics of *Acacia angustissima* (Mill.) Kuntze, *Leucaena pallida* Britton & Rose and *Mimosa scabrella* Bentham. so it does not need to be considered if all three tree legumes will be used as feed sources [17]. Also [13] research results showed that the cutting height did not significantly affected DM yield and other nutrients, ether extract and NFE, but increased CP and ash content, decreased CF content of *Desmanthus virgatus* forage.

Although the cutting methods did not significantly affect the annual DM, OM and CP forage yield, the trend of increasing annual DM, OM and CP forage yield on different methods at 3-months cutting interval could be valued economically. The branch-tip cutting at 3-months cutting interval was the best treatment that could produce 24.49 and 6.87%, 23.89 and 6.71, and 23.17 and 6.75% higher than 1m and 1.5 m cutting height DM, OM and CP forage yield, respectively.

The annual *A.pavonina* L. forage yield in this study were 17.62-23.10 t/ha/year DM; 1.57-2.15 t/ha/year OM and 2.67-3.74 t/ha/year CP, far above other medium size tree legumes forage yield reported before as *L.leucocephala* [11, 18], *C. callothyrsus* [10],

G.sepium [12, 20] *M.oleifera* [15, 16], *A.gummifera, B.grandiflora, A.niopoides, B.monandra, and I.edulis* [19], *A. mellifera* [21], *F. Macrophylla* [22], *Indigofera* sp. [14], or other tree forage plants such as *F. thonningli* [23], and *A. africana, P. erinaceus, D. oliferi* [24]. It showed that *A.pavonina* had a great potential as suplemental forage source.

Table 1. Physical and chemical properties of soil at the experimental site

pH 1:1 : H_2O	7,0
KCl 1 N	6,3
C-organik (%)	0,74
N total (%)	0,07
C/N	10
P Olsen (mg/kg)	18,33
NH4OAC 1N pH 7 :	
K (me/100g)	0,35
Na (me/100g)	0,44
Ca (me/100g)	24,56
Mg (me/100g)	0,63
KTK (me/100g)	26,09
Jumlah basa	25,98
KB (%)	100
Pasir (%)	22
Debu (%)	34
Liat (%)	44
Tekstur	liat

Table 2. Plant height and standart deviation of the 10 block.

Block	Plant height (cm)
I	308.83 ± 22.64
II	272.33 ± 24.13
III	398.50 ± 35.52
IV	322.83 ± 30.10
V	263.67 ± 18.89
VI	223.33 ± 27.33
VII	238.17 ± 23.39
VIII	245.83 ± 27.64
IX	273.83 ± 16.39
X	261.33 ± 36.05

Table 3. Means and standart deviation of plant height, number of leaves and stem diameter of *Adenanthera pavonina* L. up to 24 months after planting.

Months after planting	Plant height (cm)	Number of leaves	Diameter of stem (cm)
1	40.50 ± 10.66	6.65 ± 1.41	0.40 ± 0.13
3	49.68 ± 13.84	7.80 ± 1.46	0.43 ± 0.15
6	77.30 ± 13.21	11.40 ± 3.99	1.12 ± 0.29
9	102.28 ± 21.48	14.42 ± 9.16	1.99 ± 0.47
12	133.73 ± 31.07	19.78 ± 18.69	2.56 ± 0.44
15	166.38 ± 36.67	27.72 ± 36.13	3.23 ± 0.55
18	204.05 ± 40.98	40.85 ± 64.62	3.94 ± 0.78
21	244.55 ± 49.25	50.92 ± 83.11	4.41 ± 0.88
24	280.87 ± 54.85	61.20 ± 99.87	5.26 ± 0.96

Table 4. Annual DM, OM and CP yield of *Adenanthera pavonina* L. forage at different cutting intervals and cutting methods

Cutting Treatment	Annual DM yield		Annual OM yield		Annual CP yield	
	(kg/tree)	t/ha	(kg/tree)	t/ha	(kg/tree)	t/ha
Interval						
3-months	2.11[b]	21.09[b]	1.96[b]	19.64[b]	0.343[b]	3.431[b]
4-months	1.82[a]	16.63[a]	1.71[a]	17.11[a]	0.287[a]	2.873[a]
SEM	0.22	2.23	0.13	1.26	0.028	0.279
Methods (3-months)						
1.0 m cutting height	1.86	18.55	1.73	17.33	0.304	3.040
1.5 m cutting height	2.16	21.61	2.01	20.12	0.351	3.508
Branch tip cutting	2.31	23.10	2.15	21.47	0.375	3.745
Methods (4-months)						
1.0 m cutting height	1.76	17.75	1.64	16.39	0.278	2.775
1.5 m cutting height	1.83	18.60	1.72	17.23	0.292	2.920
Branch tip cutting	1.87	19.09	1.77	17.72	0.292	2.924
SEM	0.03	0.27	0.02	0.20	0.006	0.058
……*p value*……						
Block	$2.78x10^{-15}$	$2.78x10^{-14}$	$2.80x10^{-15}$	$2.80x10^{-14}$	$4.03x10^{-15}$	$4.03x10^{-14}$
Frequencies	$8.87x10^{--4}$	$8.87x10^{--3}$	$6.95x10^{--4}$	$6.95x10^{--3}$	$1.24x10^{-4}$	$1.24x10^{--3}$
Methods (frequencies)	0.316	0.0316	0.329	0.0329	0.0364	0.00364

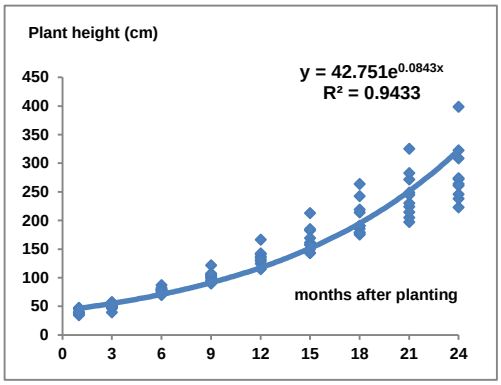

Figure 1.Growth of plant height of *Adenanthera pavonina* L. up to 24 months after planting

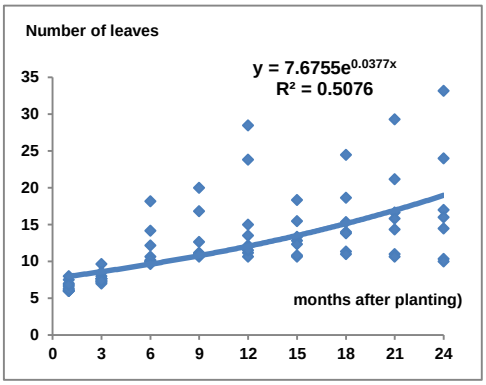

Figure 2.Growth of number of leaves of *Adenanthera pavonina* L. up to 24 months after planting

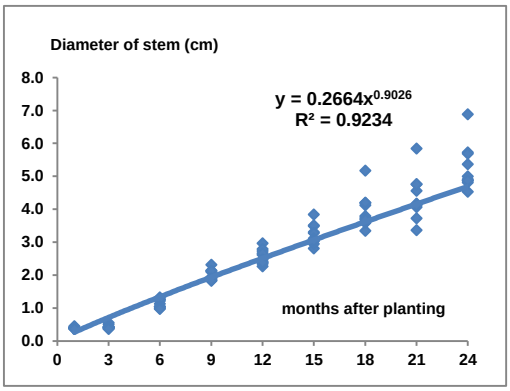

Figure 3.Growth of diameter of stem of *Adenanthera pavonina* L. up to 24 months after planting

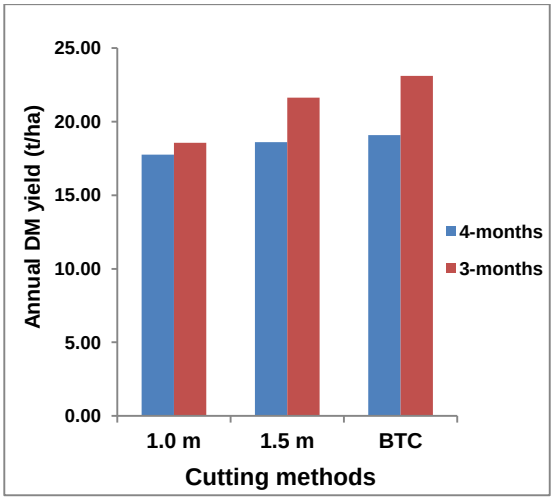

Figure 4. Annual DM yield of *A.pavonina* L.forage acording to cutting intervals and cutting methods

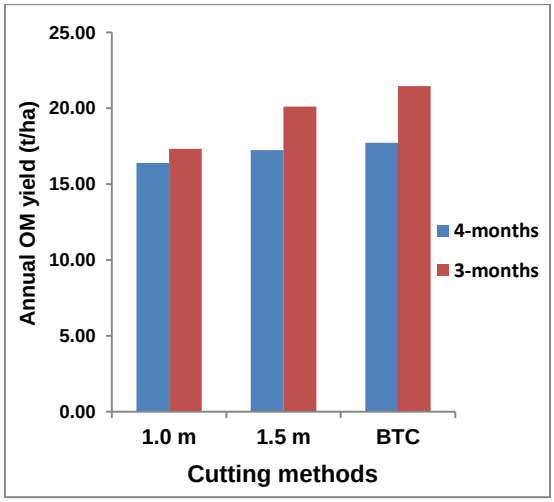

Figure 4. Annual OM yield of *A.pavonina* L.forage acording to cutting intervals and cutting methods

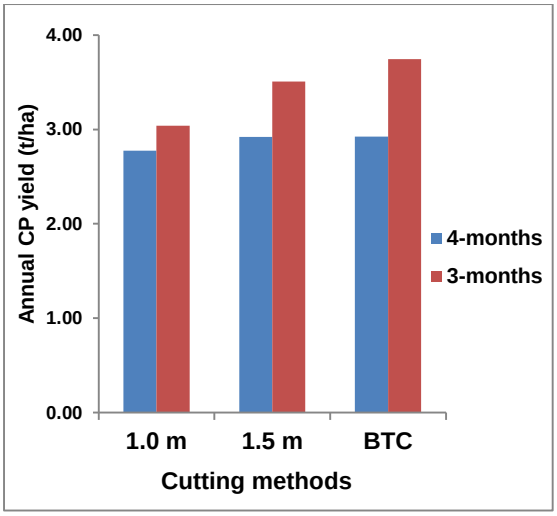

Figure 4. Annual DM yield of *A.pavonina* L. forage acording to cutting intervals and cutting methods

CONCLUSIONS

1. The growth of plant height up to 24 months after planting entering the linear growth phase, but number of leaves and diameter of stem still in initial growth phase.

2. Cutting interval significantly affected annual DM, OM, and CP forage yield. The 3-months cutting intervals DM, OM, and CP forage yield was higher than the 4-months ones.

3. Cutting methods nested in cutting intervals not significantly affected annual DM, OM, and CP forage yield. The branches cutting in 3-months cutting intervals tend to be produce the best annual DM, OM and CP forage yield.

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