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AGRONOMIC STUDY OF *PANICUM SARMENTOSUM* ON OPEN DRYLAND AGROECOSYSTEMS IN PALU VALLEY: The effect of different defoliation intervals on several forage production parameters

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ABSTRACT

The study aimed to compare several production parameters of *Panicum sarmentosum* at different defoliation intervals whose its benefit can add knowledge about the favorable defoliation interval of grasses as a feed forage source. The agronomic study was done in plot experiments comparing parameters such as number of tillers, percentage of flowering clumps, forage dry-matter (DM) content, forage DM production, and leaf:stem ratio as an effect of 3 defoliation interval treatments, namely; 4, 5, and 6 weeks with 3 repetitions. The effect of treatment on parameters was determined by the analysis of variance. Significant parameters affected by treatment were then further tested to determine the best defoliation interval between treatments by using the least significancy difference test. The results showed that the number of tillers, the percentage of forage DM content, the production of stem DM (kg/ha) and the leaves stems ratio were not affected by the defoliation interval. Defoliation interval significantly ($P<0.05$) affected the number (%) of flowering clumps, the production of forage biomass (kgDM/ha), and the production of leaf DM (kgDM/ha) of *Panicum sarmentosum* Roxb. grass. The one-year observation obtained on the productivity of *Panicum sarmentosum* Roxb. has not reflected the survivability and productivity of this type of superior local forage yet.

Keywords*:* Harsh environment, *Panicum sarmentosum*, Local grass, Agronomic attributes, Defoliation

INTRODUCTION

Forage plays an important role in the production of livestock, especially ruminants. Grass is the main component of forage feed in hot climates, including Indonesia. One of the feed forage sources is grass types that grow upright (*erect*) and form clumps. However, in Indonesia, popular types of grasses are the results of introduction, such as: elephant grass (*Pennisetum purpureum*) and bengal grass (*Panicum maximum*) from tropical Africa. On the other hand, Indonesia is rich in the diversity of plasma-nutfah plants, both endemic/native types, and those that have adapted for a long time and naturalized which is still unclear their native of origin. Thus, the recommendation of the Directorate General of Animal Husbandry, Ministry of Agriculture of the Republic of Indonesia, to the Livestock Office or the agency in charge of the livestock sub-sector, to conduct inventory and development of local feed types is very basic and reasonable view.

One of the local grasses that has the potential as a forage plant is *Panicum sarmentosum* Roxb. The symptoms and basic theories of the introduction of these agronomic attributes of grasses are very important and necessary. This grass is even expected to be suitable for use on dry land and plantation land for the integration of livestock. It is based on the vegetation community where it is found to spread naturally, in the form of an ecosystem of shrubs and *Lannea* sp. trees on dry land in Palu Valley, Central Sulawesi (Amar, 2003). This grass was found in 1999 to grow and spread naturally on scrubland in Tondo Village (0^0 50' 34.88" LS and 119^0 53' 24.82" BT) on the outskirts of Palu City (Palu City Position is 0^0 36'–0^0 56' LS and 119^0 45'–121^0 1' BT), at an average height of 0-700 m above sea level. In the year 2000, two specimens of grass plants were sent to the Bogor Botanical Garden CCP-LIPI for identification, and obtained the name of the grass is *Panicum sarmentosum* Roxb. (Roxburg).

Growing and spreading naturally, *Panicum sarmentosum* grass is found in various places in Indonesia. In Sumatra, for example, R.J. Dekker and S. Wirjahardja (1982) collected herbarium materials from an altitude of 200 m above sea level in Pematang Panggang, South Sumatra; and Sri S. Tjitrosoedirdjo (1987) at an altitude of 50 m above sea level along the irrigation canal of transmigration site in Sitiung I - Koto Agung, Punjung Island, Sawahlunto, West Sumatra. However, literature reviews show that the 'economic importance' of this grass has not touched the interests of the livestock field, as a feed forage plant. Australian New Crops Web Site (2008, australian newcrops @gmail.com) illustrated that popularity of *Panicum sarmentosum* is very low, only mentioned in 4 papers from 1926–2006). *Panicum sarmentosum* is not an object of research and publication because among other things it is seen as a weed (Watson and Dallwitz, 1992; Clayton et al., 2008); or in various places in some countries, this grass is known as a traditional medicinal plant, for example in Chhattisgarh, India (Oudhia, 2010).

Subsequent studies revealed that *Panicum sarmentosum* gave hopes for livestocks on dry land and plantations. In relation to this hope, Tarsono et al. (2021) stated that *Panicum sarmentosum* Roxb. has a good productive indication as a new species which is relatively resistence to drought; and would be equally accepted for use as forage crop (Amar et al., 2020). The initial study, which analyzed a randomly collected forage sample from the location of its spread naturally, showed that at dry matter base this forage contained 12.80% crude protein (equal of 2.05%N) if it is sampled before flowering, and 8.45% (equal of 1.35%N) after flowering (Amar and Tarsono, 2007). This attribute indicates that the nitrogen content is quite high, above the average nitrogen content of other grasses that have been popular, such as: elephant grass, and bengal grass (Amar, 2004; Tandjegau and Amar, 2007). Furthermore, Tarsono et al. (2009a) reported the results of a comparative study on several growth attributes between *P. sarmentosum* and *P. maximum* (as illustrated on Table 1).

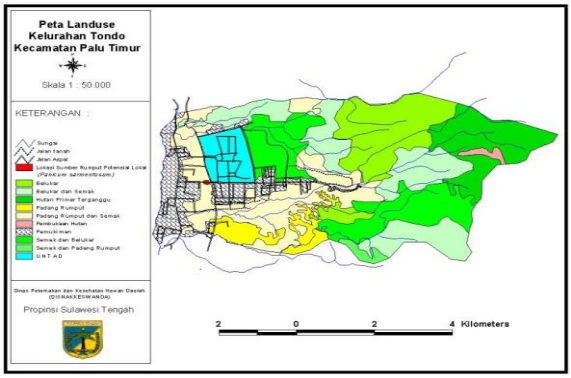

Figure 1. The Map of Tondo Village shows the location where *Panicum sarmentosum* grass was found spreading naturally.

Figure 2. *Panicum sarmentosum* grass at the site where it was first found spreading naturally (Photographs: Andi L. Amar, 2007).

Table 1. Height of plants, number of tillers, and forage dry-matter production of *P. sarmentosum* and *P. maximum*, 56 days after planting (n = 5; P=0.05).

Parameter	*P. sarmentosum*	*P. maximum*
Plant's height (cm)	149,3[a]	141,7[b]
Number of tillers/clumps	145,0[a]	81,0[b]
Production of forage dry-matters (kg/ha)	425,6[a]	235,1[b]

On the same line, different letter notations show a significant difference in values

P. sarmentosum forage is quite preferred by goats, even bali cattle and local cows of Central Sulawesi tend to choose *P. sarmentosum* forage rather than *P. maximum* forage at the same defoliation.

Tarsono et al. (2009a) showed growth parameters only in cutting grass aged 8 weeks (56 days after planting), where generally in the dry tropics, the grass is aging, flowering, and produces mature seeds at that age, so the quality of forage decreases. Although many factors also determine the age of flowering, as a comparison can be used other tropical grasses such as bengal grass in Palu Valley, it begins to bloom at an age of between 40-60 days after planting or regrowth after pruning (Tandjegau and Amar, 2004). This study examined the influence of different cutting ages on several parameters of agronomic attributes of *Panicum sarmentosum* grass as a local plasma-nutfah found growing, and developing naturally in the Palu Valley including; forage production, leaf and stem ratio. Thus, the results of the study provide vegetative attribute information produced by *Panicum sarmentosum* grass at various defoliation intervals as a potential forage feed plant; becomes the basis for the application of the recommended defoliation intervals. The development and utilization of *Panicum sarmentosum* grass is needed to reveal its potential use, especially as a source of feed forage.

METHODS

This research preparation was carried out through several stages, namely preparations of land and planting media, planting and maintenance, trimming, parameter measurements, sampling and sample analysis in the laboratory. First step; the land was cleared, ploughed, harrowed and leveled. Next, *Panicum sarmentosum* planting materials (in the form of polls) were prepared, and then planted with a planting distance of 50 cm

within rows and 80 cm between rows. Grass plants were maintained for 4 weeks at early growth by doing watering the grass regularly and also weeding by using hand-picking, as well as carrying out replanting if there were any died plants. Trimming was done at 60 days after planting by defoliating the grass at almost near soil surface. Measurements and samplings were carried out at the time of defoliation according to treatments.

Each parameter was measured as follows. The counted tillers per clump were tillers that shoot from the ground (ground tiller) not of those grow sideways (aerial tillers), and be calculated at the defoliation time. The percentage of flowering clumps was measured at the harvest times. The dry-mater content (%) was measured by forage sampling from each of the experimental plots approximately 1.5 kg; the forage was then chopped, put in an envelope, and dried using an oven with a temperature of 60^0C for 4 days. After that it was weighed, and milled.

The grinded sample was then ovened at a temperature of 105^0C for calculation of dry-matter content at the end. The forage dry-matter production (kgDM/ha) was obtained by multiplying the fresh forage production with its total dry-matter content. The production of leaf dry-matter (kgDM/ha) was obtained from the multiplication between the production of fresh leaf and the leaf dry-matter content. Production of stem dry-matter (kgDM/ha) was obtained from the multiplication between fresh stem production and stem dry-matter content. The leaf: stem ratio is a comparison between leaf dry matter weight with stem dry-matter weight.

Experimental design and data analysis

Panicum sarmentosum grass was studied in plot experiments (plot trials) in opened areas with 3 different defoliation intervals, namely:

U1 = cutting at regrowth /defoliation interval of 4 weeks;
U2 = cutting at regrowth /defoliation interval of 5 weeks; and
U3 = cutting at regrowth /defoliation interval of 6 weeks.

The above treatments were repeated 3 times. Data for each parameter was obtained from the clumps of plants which were located in the middle bedding position; this is to avoid the influence of the bedding edge. The influence of the above treatments were detected by analysis of variance for each parameter observed. Parameters that were significantly affected by at least one of the treatment will further be tested by using the least significancy difference (LSD) test to determine the difference between treatment levels on the factors that exert such a significant influence.

RESULTS AND DISCUSSIONS

The results have been obtained from the research; the number of tillers per clump, the percentage of flowering clumps at harvest times, forage dry-matter content (%), forage dry-matter production (kg/ha), leaf dry-matter production, stem dry-matter production, and leaf:stem ratio. Comparison data of the research results are shown in Table 2 to Table 4.

Table 2. Number of tillers and flowering clump proportion of *Panicum sarmentosum* at 3 different defoliation intervals.

Defoliation intervals	Number of tillers/clump	Number of flowering clumps
4 weeks	20 a	32.75 b
5 weeks	25 a	59.75 a
6 weeks	26 a	66.25 a
s.e. (LSD, P = 0,05)	3,4377	7.3456

Table 3. Dry-matter production of *Panicum sarmentosum* at 3 Different Defoliation Intervals.

Defoliation intervals	Forage dry-matter content (%)	Production of forage dry-matter (kg/ha)
4 weeks	18.21 b	1223.4 b
5 weeks	21.39 b	3202.8 a
6 weeks	25.86 a	3841.6 a
s.e. (LSD, P = 0,05)	1.4275	639.00

Table 4. Production of leaf dry-matter, stem dry-matter, and leaf:stem ratio of *Panicum sarmentosum* at 3 different defoliation intervals (regrowth 1)

Defoliation intervals	Production of leaf dry-matter (kg/ha)	Production of stem dry-matter (kg/ha)	Leaf:stem ratio
4 weeks	1074.5 b	148.9	6.2464
5 weeks	2208.6 a	994.2	2.3989
6 weeks	2146.1 a	1695.6	1.8545
s.e. (LSD, P = 0,05)	244.96	498.44	1.1426

The number of tillers per clump in this study as shown in Table 2 was not influenced by the defoliation intervals (regrowth 1). This means that at the age of 4-6 weeks *Panicum sarmentosum* Roxb. does not increase the number of tillers but adds other aspects of growth. The number of tillers per clump in this study was 20, 25 and 26 respectively for cutting ages of 4, 5, and 6 weeks. The number of tillers per clump of this grass is less than the number of tillers per clump obtained in Mura's study (2013) at the same cutting age, respectively, 43.50, 37.00, and 33.71; even in a pot trial which applied cutting aged of 5 week, tiller number just 6.10 (Tarsono, 2020). The difference in location that allows the degree of soil fertility difference determines the number of tillers per clump. Defoliation intervals (Table 2) significantly (P<0.05) affects the number (%) of the flowering clumps of *Panicum sarmentosum* Roxb. The proportion of flowering clumps at the 4-week age is less compared to the grass at age of 5 and of 6 weeks. This is natural because the growth phase of grass at 4 weeks is usually more likely in the vegetative part of the magnification and propagation of leaves and stems, while at the age of 5 and of 6 weeks the grass begins to prepare for forming flowers (generative phase) to produce seeds as a way of self-propagation so that the proportion is more.

Table 3 describes information on the content of dry-matter (DM, %) and the production of forage biomass (kgDM/ha) in response to the defoliation intervals. The defoliation intervals affects significantly (P<0.05) DM content and forage DM production. In this study, the DM content and forage DM production increased over time. Dry-matter content of grass aged of 4-5 weeks is not different from each others, while DM content of the grass at the aged of 6 weeks is significantly different from the aged of 4-5 weeks. Forage production at 4-weeks defoliation interval is significantly (P<0.05) lesser than that of 5- or 6-weeks, the two defoliation intervals is the same. Therefore, we can harvest *Panicum sarmentosum* grass at the age of 5- or 6-weeks without worrying about the larger decline in DM content. Nevertheless, DM content of the grass increases significantly over time so that it is possible to increase the number of raised livestock because pasture is able to produce more forage in the same area. Biomass productivity of a plant, including *Panicum sarmentosum* Roxb., can be predicted through how much

dry-matter is attached to the plant. This dry-matter content depends on the limiting factors that affect it. Experts, one of them is Crowder and Chedda (1982) agree that defoliation intervals have an effect on the ability of plants to regrow and on the total forage production. The production of fresh and dry materials are affected by defoliation intervals (Puger, 2002).

Table 4 describes information about the leaf DM production (kg/ha), stem DM production, and the leaf:stem ratio of *Panicum sarmentosum* forage in response to the defoliation intervals. The defoliation intervals affected significantly ($P<0.05$) the leaf DM production but not for the stem DM production and the leaf:stem ratio. In this study, the leaf DM production was in line with forage DM production. Forage DM production increased over time. The leaf DM production of the grass aged of 5 or 6 weeks was markedly higher ($P<0.05$) compared to the leaf DM production of the grass aged of 4 weeks, while the stem DM production of the grass did not affected by defoliation intervals as well as the leaf:stem ratio. The leaf:stem ratio is one of observed parameters of the forage feed because it can be used as a quality indicator of forages. The higher ratio of the leaves on to stem the higher quality of the forage feed. This is because the leaf part contains more crude protein than the stem part so that the more leaf proportion of the forage feed the better quality of that forage feed. In short, the higher leaf proportion of *Panicum sarmentosum* indicates this species can benefit for livestock and for farmers at the end.

CONCLUSIONS AND SUGGESTIONS

This study concluded as follows: (i) Tiller number, stem DM production, and leaf:stem ratio of *Panicum sarmentosum* Roxb. were not affected by the defoliation intervals planted on hars environment; (ii) The defoliation intervals affected significantly ($P<0.05$) on the percentage of the flowering clumps, forage biomass production, forage DM content, forage biomass DM production, and leaf DM production of *Panicum sarmentosum* Roxb., and (iii) Forage of *Panicum sarmentosum* could be better defoliated at the age of 5 or 6 weeks after planting.

Further study is suggested to be carried out with three main reasons namely (a) the second year agronomic test can complement the agronomic data of *Panicum sarmentosum* Roxb. obtained in this first year's study so that it can be more convincing and remove doubts about the picture of survivability this type of grass facing a harsh environment on dry land; (b) biological tests will greatly add value to the benefits of *Panicum sarmentosum* Roxb. research grass in ruminant cattle; and (c) incompleteness of the data obtained from the previous studies will make it difficult to apply for certification of local feed forage grass types and for general conclusions on the productivity of *Panicum sarmentosum* Roxb. grass on dry land.

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