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Research Article
Productivity and Quality of Pakchong-1 Hybrid Grass (*Pennisetum purpureum* × *Pennisetum americanum*) at Different Harvesting Ages and Fertilizer Levels

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Abstract

Background and Objectives: The main feed for ruminants is forage, therefore it is necessary to need forage with high productivity and high nutritional content. One type of forage with very high productivity and high nutritional content is Pakchong grass 1. This study aims to determine the productivity of Pakchong 1 grass at different harvesting ages and levels of fertilizer. **Materials and Methods:** This study was carried out at the Department of Animal Husbandry, Faculty of Agriculture, University of Lampung. This research method was experimental with a completely randomized design with a 4×3 factorial pattern, with 3 replications. The first factor is harvesting age that consisting of 4 levels each: P_1 = 40 days, P_2 = 50 days, P_3 = 60 days and P_4 = 70 days. The second factor was the level of fertilizer use from the three treatments, each: J_1 = Low dose (consisting of 50 kg urea ha^{-1}, 25 kg TSP ha^{-1} and 25 kg KCl ha^{-1}), J_2 = Moderate dose (consisting of 100 kg urea ha^{-1}, 50 kg TSP ha^{-1} and 50 kg KCl ha^{-1}), J_3 = High dose (consisting of 200 kg urea ha^{-1}, 100 kg TSP ha^{-1} and 100 kg KCL ha^{-1}). Based on ANOVA, it showed that there was no significant interaction between the treatment on all parameters ($p>0.05$). **Results:** The treatment of harvesting age also significantly affected the grass stem leaf ratio ($p<0.05$). Crude protein content and neutral detergent fiber (NDF) were also affected by the age of the cut ($p<0.05$). **Conclusion:** It was observed that there was no interaction between a dose of fertilizer and harvesting age on all parameters. There was no significant also on dose fertilizer treatment. Meanwhile, significant results on harvesting age on the parameter of biomass production, leaf-stem ratio, crude protein content and NDF content.

Key words: Pakchong-1, productivity, biomass, harvesting age, quality, nutrient, animal feed

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

The high productivity of ruminants needs to be supported by high nutritional intake so that livestock productivity is following its genetic potential. The main feed for ruminants is forage, therefore it is necessary to need forage with high productivity and high nutritional content. One type of forage with very high productivity and high nutritional content is Pakchong grass 1. Pakchong 1 grass is a hybrid grass type from elephant grass (*Pennisetum purpureum*× *P. americanum*) which was first developed in Thailand[1]. There are several advantages of this Pakchong grass including, its growth can reach more than 3 meters at the age of fewer than 60 days, gives high yields and can be harvested after 45 days with a crude protein content of 16-18%. Recently, a high yielding grass has been introduced from Thailand named Pakchong (PK) which is another variety of Napier grass and most adapted to the tropical climate[2]. The resulting grass biomass production, Pakchong grass can reach 438-500 t/ha/year with 5-6 times cutting[3]. Sweet corn is a widely distributed crop that generates agricultural waste without significant commercial value. In this study, sweet corn varieties produce large amounts of residual biomass (10 t ha^{-1})[4], sorghum forage production of 64.16 t/harvest, elephant grass production can reach[5] 200 t ha^{-1}.

The productivity and nutritional quality of the grass are strongly influenced by the age of cutting, young cutting age produces high-quality forage, high crude protein and low crude fiber content. At a young age, the grass is still in its growth stage and has not undergone much lignification, so it has high protein content and low crude fiber but there is a weakness in feeding at a young age, namely, cattle often have diarrhoea. This is due to the high water content. In addition, the productivity of young cutting age of grass is still low. When the cutting age is too old, the vegetative growth of the forage stops, it begins to enter the generative phase, in this phase the lignification process begins to occur, so that the crude fiber content is high while the crude protein content is low. When viewed from the production of forage biomass, at a young age the biomass produced is not as high as at an old age. Therefore, it is necessary to determine the appropriate cutting age for grass, to achieve high biomass production but still high nutritional quality. Each type of grass differs in the appropriate cutting age because it depends on the age of the vegetative phase and also the generative phase.

Productivity and nutritional quality of grass are also strongly influenced by inputs, namely in the form of nutrients, both macro and microelements. The presence of nutrients in the soil often occurs in shortages, this is caused by several things, for example, due to the leaching of the topsoil and also due to continuous land use. Therefore, to restore soil fertility it is necessary to fertilize in sufficient quantities. In general, grass family plants are very responsive to fertilization.

The response of each type of grass to the application of fertilizer is different. Several studies reported the use of fertilizers on grass, in their study using the type of grass Sorghum it was reported that the use of nitrogen fertilizers had a very significant effect on the growth rate, the number of tillers, protein production and significantly affected the production of dry matter, raw materials organic and crude fiber[6-8]. Another study reported Odot grass (*Pennisetum purpureum* cv Mott). The results showed that the application of urea fertilizer increased the number of tillers, stem and leaf length and fresh production[9]. This study aims to determine the productivity of Pakchong 1 grass at different harvesting ages and levels of fertilizer.

MATERIALS AND METHODS

Research sites: This study was conducted in the Lab. Integrated Field Faculty of Agriculture, University of Lampung. The research lasted for 7 months, covering land preparation, planting, fertilizing, harvesting and laboratory analysis. The study started from January to July, 2021.

Land preparation and planting: The type of soil at the research site is ultisol. Ultisols are one of the types of soil in Indonesia that have a wide distribution, it's 45,794,000 ha or about 25% of the total area of Indonesia[10,11]. In general, this soil has the potential for Al toxicity and is poor in organic matter content. This soil is also poor in nutrient content, especially P and exchangeable cations such as Ca, Mg, Na and K, high Al content, low cation exchange capacity and sensitivity to erosion[12].

Land preparation begins with land clearing, followed by ploughing. The ploughing is carried out twice, after which fertilization is carried out using manure. The land used is 120 m^2. The planting material used is cuttings of the stem. Each cutting of stem has 2 internodes. The spacing used is 60×70 cm. After one week the plants were fertilized using urea, TSP and KCl according to the treatment doses (low, medium and high doses). Harvesting of grass was carried out according to the age of treatment harvest, namely at the age of 40, 50, 60 and 70 days.

Experimental design: The design used was a completely randomized design with a 4×3 factorial pattern, with and 3 replications. So there are 36 experimental plots. The size of the experimental plots was 1.25×1.25 m, with a distance between plots of 0.7 m. Each treatment is as follows:

- **Factor 1:** The age of cutting grass, consisting of 4 levels of each age:

P_1 = 40 days
P_2 = 50 days
P_3 = 60 days
P_4 = 70 days

- **Factor 2:** The level of fertilizer use, consisting of 3 treatments each:

J_1 = Low dose (consisting of 50 kg urea ha^{-1}, 25 kg TSP ha^{-1} and 25 kg KCl ha^{-1})
J_2 = Moderate dose (consisting of 100 kg urea ha^{-1}, 50 kg TSP ha^{-1} and 50 kg KCl ha^{-1})
J_3 = High dose (consisting of 200 kg urea ha^{-1}, 100 kg TSP ha^{-1} and 100 kg KCl ha^{-1})

Parameters measured consist of forage productivity consisting of fresh production, number of tillers, the proportion of stems and leaves. The nutritional quality is measured by consisting of protein and Neutral Detergent Fiber (NDF). The data obtained were analyzed for variance, with a further test of the smallest significant difference at a 5% significance level.

Plant productivity measurement: The production of grass biomass is obtained by cutting the grass above 5 cm from the soil surface, then weighing it. The number of tillers is calculated before harvest by counting all the number of plants minus the number of parent plants. The leaf-to-stem ratio is obtained by separating the stems and forage leaves and then weighing them.

Chemical analysis: The prepared grass samples were analyzed by the method of the Association of Official Analytical Chemist[13] to determine crude protein analysis and for the NDF analysis used the Van Soest method[14].

Statistical analysis: The data were analyzed by ANOVA for analysis of variance. A comparison of means was performed using least significant different test (LSD) on a significant level of 5%.

RESULTS

Effect of cutting age and fertilizer dosage on biomass production of Pakchong-1 grass: Fresh forage production is obtained by measuring the amount of forage during harvesting. Harvesting is done when the forage is carried out according to the treatment given, namely at the age of 40, 50, 60 and 70 days. Based on the analysis of the variance test, it showed that there was no interaction between cutting age treatment and fertilizer dose on the amount of fresh produce of Pakchong grass 1 ($p>0.05$). The insignificant results were also shown by the fertilizer dose treatment. ($p>0.05$). The real results were shown by the treatment of cutting grass age ($p<0.05$). The results of the further test using the least significant difference test showed that the treatment of 40 days of slaughter (P_1) and 50 days of slaughter (P_2) was significantly different when compared to 60 days of harvest (P_3) and 70 days (P_4) ($p<0.05$), while between 40 days of harvest (P_1) and 50 of (P_2) there was no significant difference ($p>0.05$). Insignificant results were also shown between 60 days of harvest (P_3) and 70 days (P_4) ($p<0.05$).

The results of the study with a harvesting age of 70 days, the production reached 59.91 t ha^{-1}, which means that if you cut 6 times the production is around 359.46 t/ha/year (Fig. 1).

Effect of cutting age and dose of fertilizer on the number of tillers of Pakchong-1 grass: The number of tillers (tiller) is one of the parameters of grass productivity, with a large number of tillers will increase the biomass of the grass. Measurement of the number of tillers was carried out at the time of the grass before harvesting at the age of 40, 50, 60 and 70 days. The number of tillers was calculated manually against the number of shoots that grew. Based on the analysis of the variance test, it showed that there was no real interaction effect between the treatment of cutting age and dose of fertilizer on the number of tillers of Pakchong grass 1 ($p>0.05$). Treatment of cutting age and dose fertilizer also had no significant effect on the number of tillers of Pakchong grass 1 ($p>0.05$). When

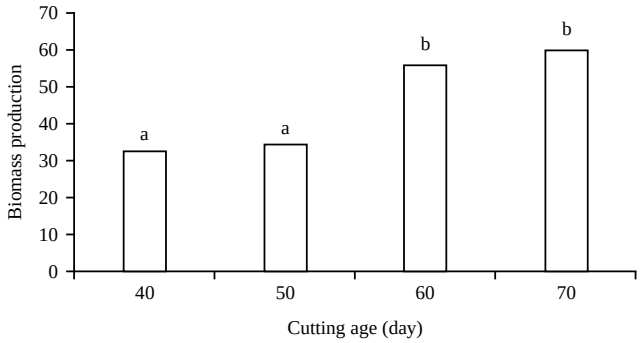

Fig. 1: Effect of harvesting age on biomass production of Pakchong 1 (t ha^{-1})
Values with different letters (a,b) show a significant difference ($p<0.05$) based on the least significant difference (LSD) test

viewed from the average, it appears that the older the slaughter age the more the number of tillers, at the age of 40 days the number of tillers was 13 and at the age of 70 days it became 21.55 (Fig. 2).

The number of tillers growing on the grass is one indicator of the quality of the grass. The more the number of tillers, the better the quality of the grass. The number of grass tillers was calculated manually against the number of shoots that grew. At the age of 40 days, the number of tillers is as many as 13 pieces and at the age of 70 days cut into 21 pieces.

Effect of cutting age and fertilizer dose on leaf and stem ratio in Pakchong-1 grass: Another indicator of grass quality is the large number of leaves in each clump because the leaves contain a lot of nutrients. The protein content of grass is more in the leaves than in the stems. The ratio of the number of leaves and stems is measured by separating the stems and weighing them. Based on the analysis of variance showed that there was no interaction between treatments on leaf and stem ratio of Pakchong-1 grass ($p>0.05$). Insignificant results were also shown by the fertilizer dose treatment. The significant effect results were shown by the treatment of harvesting age ($p<0.05$). The results of the Least Significant Difference test (LSD) showed that the treatment of 40 days of harvest (P_1) and 50 days of harvest (P_2) was significantly different ($p<0.05$) when compared with 60 days of harvest (P_3) and 70 days (P_4), while between P_1 and P_2 and P_3 and P_4 themselves were not significantly different. ($p>0.05$) (Fig. 3).

Effect of cutting age and fertilizer dose on crude protein content: One of the important nutrients in the grass is protein content. Crude protein content greatly determines the quality of the grass. The protein content of grass varies depending on the variety as well as the part of the grass, the leaves have higher protein than the stem. Based on the analysis of variance, there was no significant effect ($p>0.05$) on the interaction between treatments and treatment doses of fertilizer on the crude protein content of Pakchong grass 1. While the treatment at cutting age showed significant results. ($p<0.05$) on the levels of grass protein. Based on the results of the smallest significant difference test, it was shown that the treatment of 40 days of slaughter was significantly different compared to 50, 60 and 70 days of slaughter ($p<0.05$). Meanwhile, between the cutting ages of 50, 60 and 70 days, there was no significant difference ($p>0.05$) on the crude protein content of Pakchong 1 grass (Fig. 4).

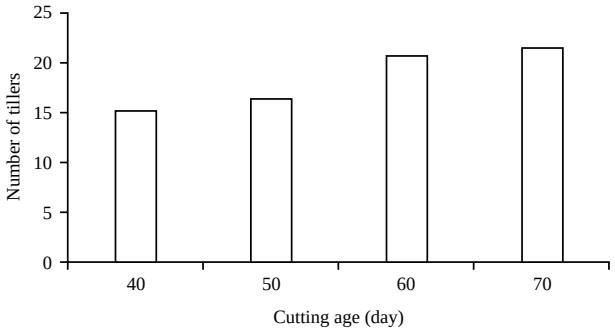

Fig. 2: Effect of harvesting age on the number of tillers of Pakchong 1

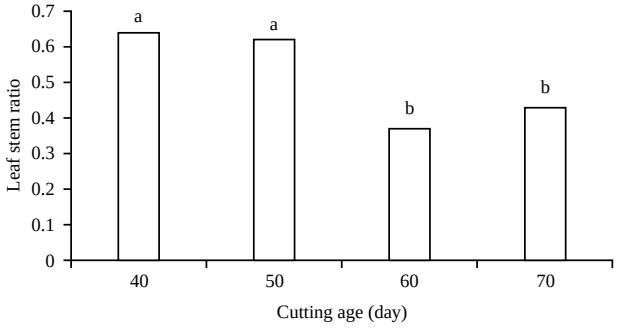

Fig. 3: Effect of harvesting age on leaf stem ratio of Pakchong 1
(a,b) show a significant difference ($p<0.05$) based on the least significant difference (LSD) test

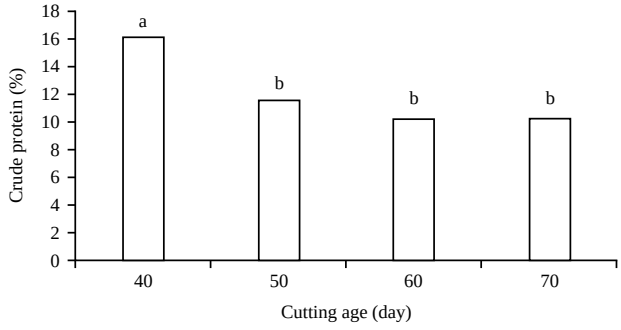

Fig. 4: Effect harvesting age on crude protein of Pakchong 1 (%)
(a,b) show a significant difference ($p<0.05$) based on the least significant difference (LSD) test

Effect of cutting age treatment and fertilizer dosage on neutral detergent fiber (NDF) content: One of the important nutritional parameters in forage is the separation of plant cell wall fraction from plant cell contents. The plant cell wall fraction is called Neutral Detergent Fiber (NDF) and the dissolved cell content fraction is called Neutral Detergent

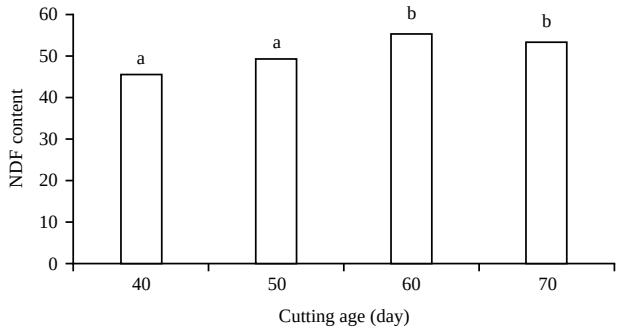

Fig. 5: Effect of harvesting age on NDF content of Pakchong 1 (%)
(a,b) show a significant difference ($p<0.05$) based on the least significant difference (LSD) test

Soluble (NDS). The content of NDF consists of cellulose, hemicellulose and lignin. The content of NDS consists of dissolved sugars, organic acids, proteins and lipids. This separation method was carried out by the Van Soest method, 1963. Based on the analysis of variance there was no significant effect of interaction between treatments and the level of fertilizer use ($p>0.05$) but significantly different ($p<0.05$) in the treatment of harvesting age.

Based on the least significant difference test, the harvesting ages of 40 and 50 days were significantly different ($p<0.05$) when compared to 60 and 70 days of treatment on the NDF content of Pakchong grass 1 (Fig. 5).

DISCUSSION

The main parameter of grass productivity is the production of its biomass. The biomass production of the research results can be seen in Fig. 1. From the bar chart, it can be seen that the biomass of Pakchong 1 grass increases with increasing harvesting age. The highest yield was achieved at 70 days of harvest (59.91 t ha^{-1}) although not significantly different when compared to 60 days of harvesting (55.71 t ha^{-1}).

According to Wangchuk *et al.*[15], reported that there was an effect of cutting intervals on the number of tillers, the highest number of tillers was achieved at the age of 40 cutting intervals with 6 cuts compared to the 50-day cutting interval with 4 cuts and the 80-day interval with 3 cuts. From these data, it can be seen that the more often the grass is cut, the more the number of tillers. Ahamed *et al.*[16], reported that the number of Pakchong grass tillers was at 40 days of cutting age, the average number of tillers was 24.6, at 50 days of cutting 17.6 and 22.6 days of cutting period.

According to the researcher reported that the cutting intervals in the three varieties of elephant grass (Pakchong 1, CO^{-3} and Giant Napier) had the highest dry matter production at a cutting age of 80 days compared to 60 and 40 days[2,15,17]. Manyawu *et al.*[18] reported that the real effect of growth stadia on yield and quality of elephant grass is at the age of 6-7 weeks. The biomass production of *Pennisetum purpureum* cv Thailand is quite high at 500 t/ha/year of fresh material, almost 2 times higher than that of ordinary elephant grass (*Pennisetum purpureum Schumach*) which on average only produces between 250-275 t/ha/year fresh ingredients. Another study stated that the biomass production produced, Pakchong grass biomass production can reach 438-500 t/ha/year with 5-6 times of cutting[3].

Another indicator of grass quality is the leaf to stem ratio. The higher the leaf-to-stem ratio, the higher the quality of the grass. This is because most of the nutritional components are concentrated in the leaves. The ratio of leaves and stems from the study can be seen in Fig. 3. The diagram shows that the ratio of leaves to stems at the harvesting age of 40 and 50 days is 0.64 and 0.62, a decrease at the cutting age of 60 days becomes 0.37 and the cutting age of 70 is equal to 0.42. This is because the grass has started to enter the generative phase, although it has not shown any flowers yet. Another thing that causes an increase in the proportion of stems is the extension of the grass segment. Wangchuk *et al.*[15] reported that the leaf and stem balance of Pakchong 1 grass was 0.94. According to Budiman *et al.*[19]. The ratio of leaves and stems decreased at 12 weeks of cutting age compared to 8 weeks of cutting age in three types of Napier grass (Taiwan, King, Mott). In the Taiwan variety Napier grass, it decreased from 1.56-0.73, so the proportion of the stems was more than the leaves, the decrease in the leaf-stem ratio was due to stem elongation and plant maturation[20,21].

Crude protein is one of the important nutrients in the grass. The protein content greatly determines the quality of the grass. The higher the protein content, the higher the quality of the grass. The crude protein content of Pakchong 1 grass can be seen in Fig. 4. Based on the bar chart, it can be seen that high protein content was obtained at 40 days of cutting (16%) and decreased at 50 (11%) 60 (10%) and 70 (70) cutting ages (10%) days. This is because at the age of 50 days and over the plant begins to mature and also occurs stem elongation, while the stem has a lower protein than the leaves. Budiman *et al.*[19], reported the results of his study using 3 varieties of elephant grass (Taiwan variety, King variety and Cv Mott), the crude protein content at 7 weeks of the harvest was 10.67, 10.43 and 12.94%, respectively, the Taiwan variety, King variety and cv. Mott. Another study reported by

Ahamed *et al.*[16], the crude protein content of Pakchong grass 1 on cutting periods 40, 50, 60 days were 11.23, 9.49 and 8.01%, respectively.

NDF is a substance that is insoluble in neutral detergent and NDF is the largest part of plant cell walls. This material consists of cellulose, hemicellulose, lignin and silica and fibrous protein[14]. The results showed that the NDF content of Pakchong 1 grass increased with increasing cutting age (Fig. 5). At 40 days of harvesting age, the NDF content was 46% and increased at 50, 60 and 70 days of harvesting, 49, 55 and 53%, respectively. This happens because the plants at an older harvesting age begin to elongate the internodes, in this phase the lignification process of the grass stem begins, so that the NDF content becomes higher. There are several research results on the NDF content of Pakchong grass. According to Sarker *et al.*[2] nutrient content of Pakchong silage were dry matter 24.71%, crude protein 9.86%, organic matter 91.65%, total ash 8.35%, neutral detergent fiber 88.06%, dan acid detergent fiber 61.89%. The study also shows digestibility nutrients in growing bull calves, dry matter 55.07%, organic matter 57.85%, crude protein 62.35, ADF 73.02% and NDF 78.19%. The nutrient digestibility was higher than other napier cultivars (BN-3) were dry matter 45.63%, crude protein 52.66%, organic matter 46.58%, ash 20.57%, ADF 65.09 and NDF 71.42%. The results of another study showed that the NDF content of Pakchong grass was 68.05, 62.54, 61.95 and 66.44% with treatment, control, the addition of mycorrhizae, addition of urea and addition of mycorrhiza+urea, respectively. The grass is harvested at the age of 60 days[21,22]. From the results of this discussion, it was found that the harvesting age had a significant effect on the parameter of biomass production, leaf-stem ratio, crude protein content and NDF content.

CONCLUSION

There was no interaction between the dose of fertilizer and harvesting age on all parameters. There was no significant also on dose fertilizer treatment. Meanwhile, significant results on harvesting age on the parameter of biomass production, leaf-stem ratio, crude protein content and NDF content.

SIGNIFICANCE STATEMENT

This study will help the researcher to uncover the critical areas of harvesting age of Pakchong-1 hybrid grass with the significant result of biomass production, leaf-stem ratio, crude protein content and NDF content, that many researchers were not able to explore. Thus a new theory on harvesting age of Pakchong-1 hybrid grass may be arrived at.

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