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Characteristics Growth and Adaptability of Dwarf-odot Elephantgrass (*Pennisetum purpureum cv. Mott*) Grown in Gorontalo at Established Year

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ABSTRACT
The study was carried out at the Experimental field of Agricultural Faculty, Gorontalo State University from the rainy season (November 2018 – May 2019) to dry season (June – October 2019). The examined variety was dwarf–odot elephantgrass (*Pennisetum purpureum cv. Mott*). The first experiment was planting density. The planting density are high density (16 plants/m², 25 cm × 25 cm of spacing), medium density (8 plants/m², 50 cm × 25 cm), and low density (4 plants/m², 50 cm × 50 cm). The second experiment was the implementation of inorganic fertilizer, namely single inorganic and compound inorganic fertilizers. Plant spacing density from high density to low density has a significantly effected (P> 0.05) on the growth characters of dwarf-odot elephantgrass were tiller number (TN), mean tiller dry matter weight (MTW) and total dry matter weight (TDMW), herbage dry matter yield (HDMY) and percentage leaf blade (PLB). The level of inorganic fertilizer, both single and compound fertilizer, showed a very significantly effected (P> 0.01) on the character of growth and production of dwarf-odot elephantgrass biomass. Single NPK level yields higher than compound NPK level on plant height (PH) growth, TN, HDMY and PLB. PH, TN, HDMY and PLB increased with the increase in levels of fertilizer dosage in both single and compound fertilizers. Achievement of HDMY per one TN dwarf-odot elephantgrass were 50%, 60% and 69% for treatment without fertilizer, compound fertilizer and single fertilizer, respectively.

Keywords: Dry matter, herbage, inorganik fertilizer, plant density

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INTRODUCTION

Elephantgrass (*Pennisetum purpureum Schumach*) is one of the most potential tropical/sub tropic grasses in producing forage or biomass as ruminant feed with very high quality and quantity. The high growth character of this elephantgrass plant is very fast (infrequence cutting) and produces so many tillers, but its nutritional content can disappear along with the age of the plant, so that good management is needed to obtain maximum results, namely the potential for fresh ingredients and high nutrient content in vegetative phase (Mukhtar, 2006). Many researchers have investigated the characteristics and structure of elephantgrass with various applications and adaptation to conditions and areas of growth, which are generally developed progeny, treatment, fertilization and application systems and modifications in an effort to further improve palatability and nutritional value.

In its development, the elephantgrass is still a cut and carry system and its pasture has not allowed the farmer or industry to be used as grazing pasture directly so that farmers often use field grass. This condition is the background and always thought by the researchers so that there is a variety of elephangrass that has a very large biomass potential but can be used as pasture grazing directly, thereby reducing labor costs. The type of grass has been developed and researched by researchers to get the best growth conditions and biomass production which of course has great potential as well as facilitating farmers as direct grazing land, so dwarf varieties of elephantgrass are found.

Some types of dwarf varieties are "Mott" dwarf (Sollenberg, 1989), Dwarf-Early and Dwarf-late (Mukhtar et al, 2006), and "odot" dwarf types have also been developed in Java, Indonesia, but it has not been spread evenly across all regions in Indonesia, especially getting this real adaptability data and the character of the dwarf-odot plant growth. Dwarf odot elephantgrass (*Pennisetum purpureum cv. Mott*) has a characteristic ratio of the ratio of leaves that is high compared to the stem, so the distance between the segments that are more tightly different from the elephantgrass that we usually encounter. This variety is a very easy to cultivate grass that is very popular with ruminants. This grass is almost similar to the normal elephantgrass, the difference is the leaves are weaker, not itchy because the leaves are soft, the growth is very fast. This Dwarf-odot was first developed in Java while this area included areas with high rainfall so that the development of growth and production of biomass was not maximal, this is because the character of the dwarf-odot variety is still almost the same as the normal variety which does not need too much water or the growth and production of biomass will be less than optimal in the rainy season with a very high intensity of rainfall, so this dwarf variety will be suitable in areas with moderate rainfall intensity.

This dwarf "odot" of elephantgrass certainly needs to be examined for the whole of Indonesia so that its adaptability and growth characteristics can be known for certain areas with high, moderate and low rainfall and most importantly the growth of dwarf-odot elephantgrass adaptation can also grow well in sub-optimal land areas that are still too much in all regions of Indonesia. This type of dwarf-odot elephantgrass needs to be developed and cultivated by farmers in Indonesia including breeders in Gorontalo Province because this type of dwarf-odot varieties of elephantgrass will provide a dual solution in meeting the quality and quantity of breeders' feed and answering the challenges of feed strengthening in Indonesia.

Environmental factors that can affect the growth and production of odot elephantgrass include setting the spacing and fertilizing treatment. Setting the spacing

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Environmental factors that can affect the growth and production of odot elephantgrass include setting the spacing and fertilizing treatment. Setting the spacing needs to be adjusted so as not to disturb the growth of odot elephantgrass. The growth and production of odot elephantgrass will be different if different spacing is used, because the spacing will affect the competition between plants. This competition or competition occurs because to get the needs of each grass such as sunlight, water, nutrition, growing space and CO_2. Likewise, with the treatment of fertilization, generally the community uses organic fertilizer to further accelerate obtaining maximum results.

In order to recommend the cultivation of dwarf-odot elephantgrass production in Eastern Indonesia, it is necessary to examine the growth of adaptability of dwarf-odot elephantgrass characteristics with the condition of regions with moderate rainfall by providing treatment of spacing and using normal amount of organic fertilizer and fertilization with inorganic fertilizers, so that it can answer the growth and development of dwarf-odot variety biomass both with and without fertilization. This treatment is done because there is a planting of grass by farmers who only allow, using makeshift organic fertilizers and those who fertilize with inorganic fertilizers.

MATERIALS AND METHODS

Plant materials

The study was carried out at the Experimental field of Agricultural Faculty, Gorontalo State University from the rainy season (November 2018 – May 2019) to dry season (June – October 2019). The examined variety was dwarf–odot elephantgrass (*Pennisetum purpureum cv. Mott*). The Study adaptability is carried out in two stages. The first stage is the implementation of treatment of plant spacing (rainy season and dry season) and the second stage is the implementation of fertilizer treatment using inorganic fertilizer (rainy season).

Experimental design

Experimant one

The experimental plots were arranged in a blocked design of Latin square method at three replications for each planting density. The planting density are high density (16 plants/m^2, 25 cm × 25 cm of spacing), medium density (8 plants/m^2, 50 cm × 25 cm), and low density (4 plants/m^2, 50 cm × 50 cm). Defoliation is carried out three times in the rainy season, that are in the months of January, March and May 2018, and twice in the dry season in the months of August and October 2018. As a basal dressing, fermented cattle manure at 600 g/m^2 applied at the beginning in the field to neutralize the field from the acidic properties of the soil. There is no applied cattle manure during the growth or after defoliation of both seasons. Defoliation is carried out every 1 month considering it is still uses stem cuttings or rooted tillers. The cutting height of defoliation was 10 cm above the ground surface.

Experiment two

In the second phase of the research is the implementation of inorganic fertilizer treatment, namely single inorganic and compound inorganic fertilizers. The experimental plots were arranged in a blocked design of Latin square method at eigth treaments and three replications. The single inorganic fertilizers used are nitrogen (urea), phosphorus (TSP) and potassium (KCL). Whereas compound inorganic fertilizers used are SP36 (nitrogen, phosphorus and potassium). The palnt spacing density used is 50 cm x 25 cm (8 plants/m2). The plants age at defoliation is 90 days. The amount of inorganic fertilizer used in the study was implemented 3 times, namely 30% before planting, 30% when the plants were 30 days old and 40% when the plants were 60 days old. The level of single and compound inorganic fertilizers at the research stage is shown in Table 1.

Table 1. Level of N-P-K single and NPK compound fertilizers used in the treatments.

No.	Level fertilizer	Single fertilizers			Compound fertilizer
		Nitrogen (N)	Phosphorus (Ph)	Potassium (P)	
		----------------Kg/Ha---------------			
1.	Control (T0)	0	0	0	0
2.	Single fertilizer (T1)	300	100	100	0
3.	Single fertilizer (T2)	450	150	150	0
4.	Single fertilizer (T3)	600	200	200	0
5.	Compound fertilizer (T4)	100	0	0	150
6.	Compound fertilizer (T5)	100	0	0	300
7.	Compound fertilizer (T6)	100	0	0	450
8.	Compound fertilizer (T7)	100	0	0	600

Description: implementation of nitrogen at T4 – T7 as the basic for giving N content.

Sampling methods for the growing period

A single plant per replication (three replications for each density) was sampled and cut at 10 cm above the ground surface, and measured for tiller number (TN), mean tiller weight (MTW), total dry matter weight (TDMW), percentage of leaf blade (PLB) and herbage dry matter yields (HDMY).

Data analysis

The data were analyzed statistically by the analysis of variance and the difference in the mean value was calculated by the least siqnificant different (LSD) method at 5 % and 1% level.

RESULTS

Experiment one

The effect of plant spacing density on the growth character of dwarf-odot elephantgrass in both the rainy and dry seasons shown in Figure 1. Defoliation of plants by treatment of plant spacing density greatly influences the growth characters and biomass production both in the rainy and dry season. In this study, plant spacing density from high density (16 plants/m^2) to low density (4 plants/m^2) has a significantly effected (P> 0.05) on the growth characters of dwarf-odot elephantgrass were tiller number (TN), mean tiller dry matter weight (MTW) and total dry matter weight (TDMW) both at the rainy and dry seasons. This effect was very possible because of the calculation of the large number of plants at each plant spacing from high, medium and low density. In addition, the amount of light entering until the ground surface is still balanced at all plant spacing considering the planting is still in the first-year establishment.

TN increased linearly after planting in each defoliation, from the frist defoliation to third defoliation during the rainy season, and from the fourth to fifth defoliation in the dry season. The growth of TN showed a largest amount in high density, follow by medium and the lowest density, but the value of the increase was almost the same at all spacing except in the third defoliation where TN experienced a very high increased in high density compared to medium and low density. This is due to the high rainfall of that month. As reported by Mukhtar, M (2006) that rainfall experiences a peak between April - May each year in Gorontalo Province (normal rainfall conditions). TN growth showed larger in the rainy season than the dry season, although the frequency of defoliation is longer in the dry season.

TN, TDMY and HDMY increased with the increase in planting density from 4 to 16 plants/m^2 in this experiment. It was already reported in elephantgrass that TN, TDMY and HDMY increased as planting density increased from 1.6 to 4 plants/m^2 by Miyagi (1990), and from 4 to 8.2 plants/m^2 by Ito et al. (1989). In this experiment, the range was expanded to 16 plants/m^2. This study showed a positive effect of increasing growth of each character with the treatment of plant spacing density. The growth in the fourth defoliation was larger because there was an extension of 1 month as a form of anticipation and gives enough time for plants to increased regrowth and production in the fifth defoliation which of course will be smaller and disrupt growth if no extension time.

The effect of plant spacing densities on dwarf-odot elephantgrass on the herbage dry matter yields and percentage leaf blade, both in the rainy and dry seasons was shown in Table 2.

Table 2. Change in herbage dry matter yields and percentage of leaf blade in dwarf-odot elephantgrass planted during rainy and dry seasons in 2018.

Season	Defoliation	Herbage Dry Matter Yield (gr/m^2)			Percentage of Leaf Blade (%)		
		LD	MD	HD	LD	MD	HD
Rainy	First	835^{e}	1.142^{de}	1.213^{d}	59,0^{ns}	60,3^{ns}	65,5^{ns}
	Second	1.115^{de}	1.377^{c}	1.592^{c}	65,1	68,0	73,8
	Third	921^{e}	1.203^{d}	1.396^{c}	55,4	57,9	60,6
Dry	Fourth	1.483^{c}	1.931^{b}	2.418^{a}	49,9	50,3	51,3
	Fifth	1.205^{d}	1.709^{bc}	1.989^{b}	40,1	43,1	49,7

Annual (**(gr/year/m^2)**)	5.559^C	7.362^B	8.608^A	----------	-----------	---------

Planting density : HD = high density (16 plants/m^2), MD = medium density (8 plants/m^2), LD = low density (4 plants/m^2). Values with different letters denote significant difference among defoliations and seasons at 5% level. NS = not significant.

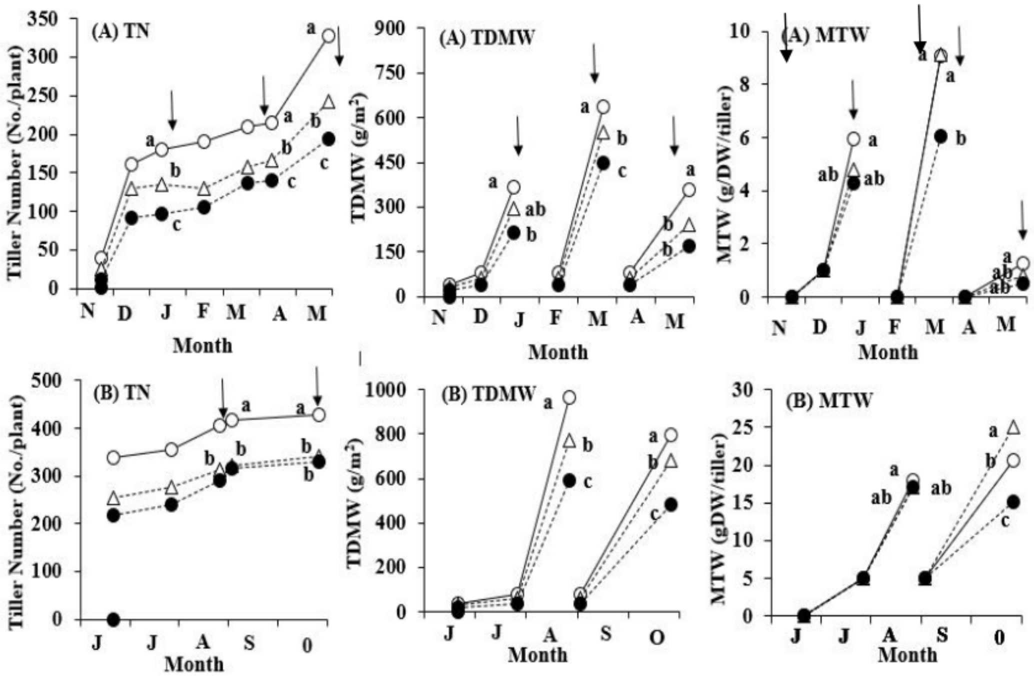

Figure 1. Change with time in tiller number (TN), total dry matter weight (TDMW), and mean tiller weight (MTW) of dwarf-odot elephantgrass during rainy season (A) and dry season (B) in 2018. High density (O), medium density (Δ) and low density (●). Arrows indicate the date of defoliating at 10 cm above ground surface. Figures with different letters denote significant difference at 5% level.

Plant spacing densities was also significantly affected (P>0.05) in dwarf-odot elephantgrass herbages production while percentage of leaf blade (PLB) had no significant effected. As with MTW and TDMW, HDMY generally increases from the first defoliation to the fifth defoliation, except in the third defoliation where there is a slight decrease in herbage yield. The HDMY obtained higehst herbage production occurs in the fourth defoliation in each plant spacing density. The annual HDMY was the highest in high density follow by middle density and the lowest in low density.

In the previous results, it was seen that TN increased linearly with increasing plant spacing densities from 4-16 plants / m2 and from first defoliation to fifth defoliation. These correlations suggest that as planting density increases, HDMY increases with the concomitant increase in TN, and that as cutting frequency increases. These correlations should be considered in aspect to herbage quality or fertilizer treatmen (Ishii et al, 1996). This was similar to the results of previous studies reported by Mukhtar, M. (2007) that in dwarf varieties, both cv. dwarf-late and cv. dwarf-early, did not show a significant effect on the increase in PLB despite significant influence from the mean tiller weight (MTW). Woodard and Prine (1991) also reported that the dwarf variety of Mott was less sensitive to the increased cutting frequency. This characteristic, insensitive to the cutting frequency may be due to the earlier recovery of ground cover by the leafage after harvest (Gardner et al, 1985) because of larger TN in dwarf-odot elephantgrass.

Experiment two

The effect of inorganic fertilizer on changes in growth characters of growth and biomass production of dwarf-odot elephantgrass was shown in Table 3.

Table 3. The Average of growth characters (plant height and tiller number) and biomass productions (herbage dry matter yields and percentage leaf blade) of dwarf-odot elephantgrass as affected by conducting levels of inorganic fertilizer.

Variables	Level of N-P-K single and NPK compound fertilizers							
	T0	T1	T2	T3	T4	T5	T6	T7
Plant Height (cm)	165 ^{d}	212 ^{b}	224 ^{ab}	237 ^{a}	189 ^{c}	191 ^{c}	209 ^{b}	211 ^{b}
Tiller Number (No./plant)	60 ^{c}	66 ^{b}	71 ^{a}	66 ^{b}	61 ^{c}	62 ^{c}	64 ^{bc}	71 ^{a}
Herbage dry matter yields (kg/m^2)	121 ^{d}	204 ^{b}	225 ^{a}	234 ^{a}	141 ^{c}	152 ^{c}	165 ^{c}	200 ^{b}
Percentage Leaf Blade (%)	48 ^{d}	51 ^{c}	54 ^{b}	58 ^{a}	49 ^{cd}	51 ^{c}	50 ^{c}	51 ^{c}

Description: T0 - T7 are the levels of single and compound fertilizer as shown in Table 1. Values with different letters denote significant difference at 1% level.

The level of inorganic fertilizer, both single and compound fertilizer, showed a very significantly effect (P> 0.01) on the character of growth and biomass production of dwarf-odot elephantgrass. Hakim (2005) reported in the previous study that the used of a single N-P-K fertilizer at a dose of 100 kg/ha urea, 50 kg/ha TSP, 10 tons of manure significantly increased the growth of normal variety of elephantgrass. The effect of giving this level of inorganic fertilizer greatly accelerates the process of absorption of NPK in the soil in the short term compared to the provision of new organic fertilizer which can show absorption effects at 6 - 8 months.

In this study, all treatments showed highest growth and biomass production results compared to the treatment without fertilization (control), both in the single N-P-K and the NPK compound fertilizer. These results indicated that the dwarf odot of elephantgrass fertilized will provide a good growth effect because plant nutrients are available from the elements nitrogen, phosphorus and potassium. Seseray et al (2013) state that the use of a single N-P-K fertilizer at a dose of 200 kg/ha urea, 100 kg/ha TSP, 100 kg/ha KCL provides better plant height growth because it speeds up the process of fertilizer absorption in the soil.

Comparing the effects of the two types of inorganic fertilizers, a single N-P-K treatment showed better results compared to NPK compound treatments. Both single NPK and compound NPK showed an increase in plant height (PH) and tiller number (TN) growth and biomass production that were herbage dry matter yields (HDMY) and percentage of leaf blades (PLB) as the dosage or level of each type increased. the fertilizer. Both single N-P-K and compound NPK obtained peak production at the highest dose at T3 (600 N, 200 P and 200 K) and T7 (600 NPK) for single fertilizer and compound fertilizer, respectively.

DISCUSSION

Large growth in TN has a positive influence on large production of TDMW and MTW as well as herbage dry matter yield (HDMY). The average TDMW and MTW production showed larger in high density, followed by medium density and lowest at low density both in the rainy and dry seasons, respectively. TDMW and MTW increased from the first defoliation to the second defoliation but decreased in the third defoliation in the rainy season, even though during that production month, there was a high rainfall. TDMW and MTW also experienced growth and production decreased from defoliation fourth to fifth defoliation at all spacing. However, due to the extended time from the third defoliation to the fourth defoliation, TDMW and MTW increased dramatically, then showed decreased in the fifth defoliation, this was due to the reduction of leaf and stem volume caused by the dry season (Mukhtar M, 2006).

As with TN, TDMW and MTW experienced peak growth and production at the fourth defoliation, both in the rainy season and dry season. The average growth of TDMW and MTW looks bigger in the rainy season than the dry season. Defoliation in the dry season was conducted twice because if conducted three times defoliation as in the rainy season it will disrupt the growth process (Rusland et al, 2006) because defoliation is done at the beginning of November 2018, while that month is the peak of the dry season, so the sixth defoliation is not done again because the stubbles was smaller (approaching the defoliation height of 15 cm), and it is very risky to do defoliation because it will reduce food reserves for further regrowth. If food reserves are less, then it will greatly affect growth for the next one year. Thus, the growth character of dwarf-odot elephantgrass can be defoliated every month for 4 consecutive months then it must be extended 2-3 months in the rainy season and only twice in the dry season in the first year of planting. In the second year, defoliation can be carried out 4 times in the rainy season and three times in the dry season, this is due to the increasing number of TN, which is certainly very available food reserves on the stem after defoliation.

From the previous experiment, dwarf-odot is assessed to be more sensitive to the decrease in air temperature than other varieties in pennisetum species like normal varieties. A great decline of HDMY at the third cutting may be attributed to the non-heading characteristics of dwarf-odot. Since elongated stem functions as a storage organ, dwarf-odot may lack in the sink capacity under a low air temperature at the fifth cutting in dry season (Mukhtar, 2006).

PH, TN, HDMY and PLB increased with the increase in levels of fertilizer dosage in both single and compound fertilizers. Increasing PH and TN greatly affected to biomass production, that were HDMY and PLB which showed high growth and production. PH, TN, HDMY and PLB were generally showed to be higher in single fertilizer (T1 - T3) compared to controls (T1) or compound fertilizer (T4 - T7). This is due to the high element of Nitrogen (N) in a single fertilizer. If more N elements are available than other elements, more protein is produced, the leaves grow larger so photosynthesis increases. The higher level of N the faster the process of synthesis of carbohydrates into proteins and protoplasm, the smaller the ratio available for cell walls, especially N-free carbohydrates such as calcium, cellulose, and lignin with low N. The plant growth is stimulated through the provision of fertilizers with its N-element content (Hendarto, 2011).

The achievement of TN and PLB did not show the consistency of achievement in HDMY. Achievement of HDMY per one TN dwarf-odot elephantgrass is 50%, 60% and 69% for treatment without fertilizer (control), compound fertilizer and single fertilizer, respectively.

Likewise, the achievement of PLB in each one of the dwarf-odot elephantgrass plants was an average of 60%, 69% and 75% for treatment without fertilizer (control), compound fertilizer and single fertilizer, respectively.
The more the amount of fertilizer used, the more tiller number of dwarf-odot elephantgrass indicates that fertilization factor is very necessary for plant growth because the required nutrient content is not fully available in the soil. Percentage of growth was highly dependent on the availability of nutrients in the soil specifically nitrogen (Ella, 2002). The higher the level of nutrient solubility, the more nutrients are used by plants to produce so as to increase the production of dry matter. This might have something to do with the competency factor between plants and the number of shoots to obtain nutrients contained in the soil. Competence to get these nutrients will affect the size and appearance of plants per individual and tiller number and stems become small. The content of dry matter is highly dependent on forage species, the age of plants (young or old) the older the plants, the higher the dry matter content but the decreased nutrient content (Ishii et al 1998; Sunusi et al, 1997).

CONCLUSION

Plant spacing density from high density (16 plants/m^2) to low density (4 plants/m^2) has a significantly effected (P> 0.05) on the growth characters that were tiller number (TN), mean tiller dry matter weight (MTW) and total dry matter weight (TDMW) and biomass production that were herbage dry matter yields (HDMY) and percentage leaf blade (PLB) of dwarf-odot elephantgrass both at the rainy and dry seasons. TN, TDMW, MTW, HDMY and PLB increased linearly after planting in each defoliation, from the frist defoliation to third defoliation during the rainy season, and from the fourth to fifth defoliation in the dry season.
With the rainy and dry conditions in Gorontalo, the implementation of defoliation every month can only be conducted 3 – 4 times in the rainy season and twice in the dry season. Towards the end of the rainy season or the beginning of the dry month, defoliation must be extended to 2 months. The level of inorganic fertilizer, both single and compound fertilizer, showed a very significant effect (P> 0.01) on the character of growth and production of dwarf-odot elephantgrass biomass. Single NPK level yields higher than compound NPK level on plant height growth, tiller number, fresh material production and leaf percentage.
PH, TN, HDMY and PLB increased with increasing in levels of fertilizer dosage in both single and compound fertilizers. Increasing PH and TN greatly affected biomass production, that are HDMY and PLB which show high growth and production. Achievement of HDMY per one TN dwarf-odot elephantgrass is 50%, 60% and 69% for treatment without fertilizer (control), compound fertilizer and single fertilizer, respectively. Likewise, the achievement of PLB in each one of the dwarf-odot elephantgrass plants was an average of 60%, 69% and 75% for treatment without fertilizer (control), compound fertilizer and single fertilizer, respectively.

ACKNOWLEDGEMENT

We would like to thank the local government of Bone Bolango Regency for their attention and assistance in completing this research and hope to plant this dwarf odot elephantgrass as ruminat feed in the Bone Bolango region, Gorontalo Province of Easten Indonesia.

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Characteristics Growth and Adaptability of Dwarf-odot Elephantgrass (Pennisetum purpureum cv. Mott) Grown in Gorontalo at Established Year

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