



Effect of Variability of Water Supply During 20 Days Before Harvest on the Morphological Characteristic of Red Elephant Grass (*Pennisetum purpureum* cv. Red)

Ainy Novitasari¹, Rizka Muizzu Aprilia², Kusmartono³, Ifar Subagiyo³

¹Magister's Program Student, Faculty of Animal Science, Universitas Brawijaya, Veteran St. Malang, 65145 East Java, Indonesia

²Lecturer, Faculty of Food Security, Universitas Negeri Surabaya, Lidah Wetan St. Surabaya, 60213 East Java, Indonesia

³Lecturer, Faculty of Animal Science, Universitas Brawijaya, Veteran St. Malang, 65145 East Java, Indonesia

ABSTRACT: This study aimed to determine the effects of different watering intervals, amount of water, and their interactions during the 20 days before harvest on the morphological characteristics of Red Elephant Grass (*Pennisetum purpureum* cv. Red). This plant grows upright with thick stems and strong roots, and it can thrive in various soil conditions, including marginal soils, making it easy to find and widely cultivated (Ariyanto et al., 2020). The grass was propagated using stem cuttings planted in polybags and maintained accordingly. At 90 days of age, the plants were trimmed. The subsequent stage involved a maintenance period of 50 days to allow regrowth, followed by a 20-day treatment period. A factorial, completely randomized design (CRD) was used, and two factors were used. The first factor was watering interval (K): K1 – every 3 days, K2 – every 6 days, and K3 – every 9 days. The second factor was the amount of water (P): P1 – 4.61 L, P2 – 3.46 L, P3 – 2.30 L, and P4 – 1.15 L. The grass was harvested 70 days after trimming. Variables measured included plant height, number of leaves, tillers, and leaf-to-stem ratio. The data were analyzed using analysis of variance (ANOVA) followed by Duncan's Multiple Range Test (DMRT). The results showed that watering every 9 days produced the tallest plants, while the highest number of leaves was observed with a 6-day watering interval. An adequate amount of water improved the leaf-to-stem ratio, indicating better forage quality. Conversely, the number of tillers did not show significant changes, likely because treatments were applied after the early growth phase. Overall, Red Elephant Grass was able to grow optimally with less frequent watering and the appropriate amount of water.

KEYWORDS: Amount of water, forage quality, morphological characteristic, *pennisetum purpureum*, watering interval.

INTRODUCTION

Forage is the primary feed source for ruminants as it contains crude fiber essential for maintaining rumen pH stability and microbial activity. Among the various types of forage, Elephant Grass (*Pennisetum purpureum*) is recognized as a high-yielding, fastgrowing, easily cultivated species tolerant to harsh environmental conditions such as drought. This plant grows upright with thick stems and strong roots, and it can thrive in various soil conditions, including marginal soils, making it easy to find and widely cultivated (Ariyanto et al., 2020). One of the cultivars that has recently gained attention is Red Elephant Grass (*Pennisetum purpureum* cv. Red), which is characterized by its reddish stems and leaves, as well as its softer leaf texture. Although it resembles common elephant grass in form, this cultivar is easily distinguishable due to the red or purple coloration of its stems and leaves. The reddishpurple color of Red Napier is attributed to its high anthocyanin content, which gives the plant a dominant hue of purple, red, or blue (Zhou et al., 2019). In addition to its high adaptability, morphological characteristics such as plant height, number of leaves, number of tillers, and leaf-to-stem ratio are crucial for determining the productivity and quality of this forage crop. Plant height increase reflects enhanced cell division driven by increased assimilates (Harjanti & Tohari, 2014). According to Lekitoo et al. (2020), the leaf-to-stem ratio can indicate forage quality since this ratio compares the quantity of leaves and stems, with leaves generally offering better nutritional quality than stems. Among forage grasses, Benggala grass shows the highest leaf-to-stem ratio (2.98), followed by Setaria (2.41), and Elephant Grass (1.86).

One critical environmental factor influencing plant morphology is water availability. Water plays a vital role in photosynthesis. Plants with high photosynthate production tend to develop more leaves, supporting the formation of new organs such as leaves and stems, ultimately increasing plant dry weight. The condition reflects the efficiency of photosynthesis and its

contribution to plant growth and development (Firda, 2009). Water supply to plants should be adjusted to actual water needs, because both lack and excess water can have a negative impact on plant growth. Water is an important factor in plant life. (Leopold and Kriedemann, 2003; Maryani, 2012). Lack of water can cause physiological and biochemical changes in plants. These changes aim to maintain water reserves and maintain photosynthetic activity, for example by reducing the opening of stomata to suppress water loss (Kumar et al., 2011). The availability of abundant water in the soil increases the solubility of nutrients needed by plants (Ressie, et al., 2018). Variations in the amount of water and frequency can affect vegetative growth, including plant height, leaf surface area, and tiller number. Water deficiency may cause wilting, stunted growth, and reduced leaf number, while excess water can limit oxygen uptake by roots and lead to rot. Information on how Red Elephant Grass responds to different watering intervals and volumes regarding morphological characteristics is still limited, especially during the final growth stage before harvest. Therefore, this study was conducted to investigate how the regulation of watering intervals and amount of water during the 20 days before harvest affects Red Elephant Grass's morphological characteristics.

MATERIALS AND METHODS

The field experiment was conducted at the Sumber Sekar Field Laboratory Greenhouse, Faculty of Animal Science, Universitas Brawijaya. Red Elephant Grass (*Pennisetum purpureum* cv. Red) biomass was harvested 70 days after trimming. The materials used in this study included 48 stem cuttings of Red Elephant Grass, each with three nodes and a length of 20–25 cm. Each cutting was planted in a black polybag with a 50 cm diameter, filled with 20 kg of field-sourced soil. Fertilization was done using NPK and Urea, and water was applied according to the treatment design. The tools utilized in the experiment comprised a hoe for loosening soil, pruning shears for trimming and harvesting, and a measuring cup for accurate water application. Biomass and soil were weighed using a Camry digital scale with a 5 kg capacity and a crane scale for larger weights. Plant height was measured using a ruler and a tape measure. Additionally, plastic bags and black or white markers were used for labeling samples and polybags to ensure accurate identification throughout the experiment.

A Factorial Completely Randomized Design (CRD) was used with two factors:

1. Watering Interval (K):
 - K1: every 3 days
 - K2: every 6 days
 - K3: every 9 days
2. Amount of Water per Polybag (P):
 - P1: 4.61 L
 - P2: 3.46 L
 - P3: 2.30 L
 - P4: 1.15 L

Treatments were applied for 20 days, starting from 50 days after trimming (trimming was done at 90 days after planting). Prior to treatment, all plants were watered with 4.61 L every 3 days, based on the estimated field capacity (Effendi, 2008). This volume (P1) was used as the reference; P2 was 75% of P1, P3 was 75% of P2, and P4 was 75% of P3.

Experimental Procedure

The planting medium (soil) was cleaned, loosened, homogenized, and weighed as much as 20 kg per polybag (size 25 × 50 cm). The cuttings were planted at a depth of 10–15 cm with one segment underground.

Basic fertilization with NPK was given 7 days after planting (0.03125 g/polybag), followed by Urea (2 g/polybag) 7 days after pruning. Weed control was done manually once a week.

From planting to 50 days after pruning, the plants were watered every 3 days with 4.61 L to maintain soil moisture. After that, watering followed the treatment schedule until harvesting 70 days after pruning.

Pruning was done 90 days after planting to encourage uniform regrowth. Morphological data (plant height, number of leaves, number of tillers) were measured before harvest. Plant height started from point 0 cm or the base of the plant stem touching the soil surface. Harvesting was done by cutting the plant 5 cm above the soil surface. Leaves and stems were separated to calculate the leaf to stem ratio.



Data Analysis

Data were recorded in Microsoft Excel 2010 and then analyzed using Analysis of Variance (ANOVA). If significant differences were observed ($P < 0.05$ or $P < 0.01$), further analysis was conducted using Duncan’s Multiple Range Test (DMRT).

RESULT AND DISCUSSION

The analysis of variance (ANOVA) results showed that the watering interval had a highly significant effect ($P < 0.01$) on plant height and number of leaves. Meanwhile, amount of water had a significant effect ($P < 0.05$) only on the leaf-to-stem ratio. The interaction between watering interval and amount of water had a highly significant effect ($P < 0.01$) on the leaf-to-stem ratio of Red Elephant Grass. The morphological characteristics data of Red Elephant Grass are presented in Table 1.

Table 1. Morphological characteristics of Red Elephant Grass

Treatment	Plant Height (cm)	Number of Leaves (strands)	Number Offshoots/Clump	of Leaf and Stem Ratio
Watering interval				
K1	99.13 ^a ± 8.58	53.94 ^b ±8.26	13.69 ± 4.63	2.19 ± 0.53
K2	107.25 ^b ± 15.00	80.50 ^c ±7.51	11.88 ± 3.65	1.97 ± 0.48
K3	124.38 ^c ±19.03	27.25 ^a ±5.35	18.40 ± 3.74	1.80 ± 1.06
P Value	P<0.01	P<0.01	P>0.05	P>0.05
Amount of water				
P1	102.00 ± 11.70	45.67 ± 13.34	12.83 ± 1.40	2.40 ^c ±0.54
P2	110.25 ±24.85	46.75 ± 15.73	12.75 ± 4.56	1.86 ^b ±0.27
P3	118.08 ± 23.87	39.92 ± 11.01	13.50 ± 5.79	1.73 ^a ±0.41
P4	110.67 ± 16.55	43.00 ± 16.62	10.33 ± 2.81	1.95 ^b ±0.56
P Value	P>0.05	P>0.05	P>0.05	P<0.05
Watering interval × Amount of water				
K1P1	95.25 ± 5.74	51.50 ± 7.77	13.00±2.58	2.32 ^{ab} ±0.63
K1P2	97.5 ±11.09	57.00 ± 9.76	11.50±4.04	1.94 ^{ab} ±0.21
K1P3	104.75 ±11.90	46.50 ± 6.03	17.00±7.79	2.35 ^{ab} ±0.72
K1P4	99.00 ± 5.50	60.75 ± 9.46	13.25±1.26	2.14 ^{ab} ±0.56
K2P1	112.75 ± 13.82	56.00 ± 11.94	12.75±0.50	1.49 ^a ±0.24
K2P2	103.5 ± 17.82	55.50 ± 5.92	13.75±5.12	2.15 ^{ab} ±0.25
K2P3	108.5 ± 19.74	46.50 ± 4.80	11.75±4.35	1.84 ^{ab} ±0.21
K2P4	104.25 ± 8.81	43.25 ± 7.37	9.25±2.50	2.38 ^{ab} ±0.62
K3P1	98.00 ± 6.48	29.50 ± 3.87	12.75±0.50	3.34 ^b ±0.73
K3P2	129.75 ± 32.36	27.75 ± 7.27	13.00±5.48	1.49 ^a ±0.35
K3P3	141.00 ± 22.32	26.75 ± 6.18	11.75±4.35	0.99 ^a ±0.29
K3P4	128.75 ±14.95	25.00 ± 4.08	8.50±1.91	1.33 ^a ±0.50
P Value	P>0.05	P>0.05	P>0.05	P<0.01

The ANOVA results in Table 1 show that the watering interval had a highly significant effect ($P < 0.01$) on the plant height of Red Elephant Grass, whereas the amount of water and the interaction between the two had no significant effect ($P > 0.05$). Plant height tended to increase with longer watering intervals. Treatment K3 (watering every 9 days) resulted in the tallest plants, while K1 (watering every 3 days) showed the lowest results. Elephant grass possesses several desirable characteristics, such as high yield per unit area, tolerance to drought, and high water use efficiency (Kabirizi et al., 2015). The highest average plant height in K3 reached 124.375 cm. This increase in plant height is due to enhanced cell division and enlargement driven by assimilate accumulation (Harjanti and Tohari, 2014). Gardner et al. (1991) explained that plant height growth occurs through increased cell number and size. These findings suggest that Red Elephant Grass adapts well to less frequent watering, indicating its tolerance to limited water



availability. Other factors influencing plant height include nutrient availability, sunlight intensity, and sufficient nutrition. According to Ressie et al. (2018), optimal watering conditions activate growth hormones that expand cell walls. The condition also promotes sugar formation, enlarging vacuoles, supporting cell growth, and increased plant height. In contrast, too frequent watering, such as in K1, can cause water saturation around the roots, hinder root respiration, reduce nutrient uptake, and increase the risk of root rot, ultimately impairing growth or even causing plant death.

The ANOVA results also show that the watering interval had a highly significant effect ($P < 0.01$) on the number of leaves of Red Elephant Grass. However, the amount of water and the interaction between watering interval and amount of water had no significant effect ($P > 0.05$) on the number of leaves. The highest number of leaves was observed in K2 (watering every 6 days), with an average of 80.50 leaves. The lowest was found in K3 (watering every 9 days). A moderate watering interval (K2) allows the plant to absorb and utilize water optimally for photosynthesis, resulting in more leaves. On the other hand, the K3 treatment caused water deficiency, leading to wilting, leaf shrinkage, reddening, and drying. Some dried leaves dropped, reducing the total leaf count. Napier grass undergoes morphological changes under water stress conditions, such as leaf rolling, reduced stomatal opening, and increased water use efficiency (Negawo et al., 2017). Wilting occurred because water uptake could not match the rate of water loss through evaporation (Harwati, 2007). In K1 (watering every 3 days), leaf numbers were also lower than in K2, possibly due to waterlogging that reduced oxygen availability in the soil, disrupting root function and plant growth. Both water deficiency and excess negatively affect plant growth and yield (Nugraha et al., 2014). Therefore, watering must be adjusted to plant needs to prevent water stress and productivity loss.

The ANOVA results in Table 1 also show that the watering interval, amount of water, and their interaction had no significant effect ($P > 0.05$) on the number of tillers in Red Elephant Grass. The highest tiller number was found in K3 (18.40 clump), in water level P3 (13.50 clump), and in the interaction K1P3 (17.00 clump). Water facilitates the absorption and distribution of nutrients, which are essential for photosynthesis and plant growth. Although the number of tillers did not increase significantly, supplying 2.30 liters of water (P3) created optimal conditions for tiller development, as the plants received sufficient water and nutrients (Ressie et al., 2018). Before the treatments began, all plants were evenly watered from the first day after trimming to day 50. During this period, the plants were in the early vegetative phase, a stage of active growth where water is critical for photosynthesis and shoot formation. Since watering treatments were applied after 50 days, they had no significant impact on tiller number. According to Ressie et al. (2018), plants require nutrients for meristematic tissue development during vegetative growth, primarily carbon and nitrogen. Low soil water content reduces the concentration of dissolved nutrients, hindering uptake. Conversely, excess water makes soil too moist, causing root rot. Thus, a balanced water supply is crucial for optimal tiller development.

The ANOVA data in Table 1 also show that the amount of water significantly affected ($P < 0.05$) the leaf-to-stem ratio, and the interaction between watering interval and amount of water had a highly significant effect ($P < 0.01$). The highest ratio was observed in P1 (2.40), and the lowest in P3 (1.73). The optimal water conditions in P1 supported maximum leaf growth without causing water stress or oxygen deficiency in the roots. P2 to P4 showed a declining trend due to increasing drought stress. Red Elephant Grass is a heterozygous plant with relatively broad, long, thin leaves and prominent veins (Asngad and Rahmawati, 2021).

The leaf-to-stem ratio in short types of Elephant Grass is generally higher (1.23–1.51) than in tall types (0.62–0.70) (Seseray et al., 2013). This study supports those findings as the ratios observed were all above 1. According to Dumadi et al. (2021), leaves contain relatively less water than stems, so short types with more leaf portions have higher dry matter content than tall types. The Red Elephant Grass cultivar has the highest LSR (leaf-to-stem ratio) among tall cultivars (Zailan et al., 2016).

The interaction between watering interval and amount of water showed the highest leaf-to-stem ratio in K3P1 (3.34) and the lowest in K3P3 (0.99). According to Lekitoo et al. (2020), the leaf-to-stem ratio is a suitable parameter for forage quality because it reflects the proportion of edible and nutritious leaves compared to stems. Leaves generally have higher quality than stems, so a higher ratio indicates better forage quality. The dry weight of leaves influences the ratio of stems. A higher ratio reflects more leaves, suggesting better forage quality. Livestock prefer leaves due to their higher palatability, digestibility, and nutritional content, especially in protein and fat. Thus, optimal water availability (sufficient quantity though infrequent) promotes leaf growth and increases the leaf-to-stem ratio. In contrast, severe water limitations reduce leaf growth, decreasing the ratio due to relatively unchanged stem biomass.



CONCLUSION

The results show that watering every 9 days produces the tallest Red Elephant Grass plants, while the highest number of leaves was found with watering every 6 days. Sufficient water increases the leaf-to-stem ratio, indicating better forage quality. Conversely, the number of tillers did not change significantly, likely because treatments were applied after the early growth phase. Red Elephant Grass can grow optimally with adequate water and infrequent watering.

REFERENCES

1. Ariyanto, B. F., Luklukyah, Z., & Rahayu, T. P. (2020). *Pertumbuhan Tanaman Rumput Gajah (Pennisetum purpureum) yang Diberi Penambahan Pupuk Kandang Kambing* (Doctoral dissertation, Sebelas Maret University).
2. Asngad, A., dan Rahmawati, A. N. 2021. Kualitas Kertas Seni dari Limbah Cangkang Telur dan Rumput Gajah dengan Penambahan Pelarut NaOH dan CaO. In *Prosiding SNPBS Seminar Nasional Pendidikan Biologi dan Saintek* (pp. 524531).
3. Dumadi, E. H., Abdullah, L., dan Sukria, H. (2021). Kualitas hijauan rumput gajah (*Pennisetum purpureum*) berbeda tipe pertumbuhan: review kuantitatif. *Jurnal Ilmu Nutrisi dan Teknologi Pakan*, 19(1), 6-13.
4. Firda, Y. 2009. Respon tanaman kedelai (*Glycine max (L.) Merril*) terhadap cekaman kekurangan air dan pemupukan kalium. Skripsi Fakultas Pertanian Universitas Riau. Pekanbaru
5. Gardner, F.P, R.B. Pearce dan R.I. Mitchell. 1991. Fisiologi tanaman budidaya. UI press. Jakarta.
6. Harjanti, R. A., dan Tohari, S. N. H. U. 2014. Pengaruh takaran pupuk nitrogen dan silica terhadap pertumbuhan awal (*Saccharum officinarum L.*) pada inceptisol. *Vegetalika*, 3(2), 35-44.
7. Kabirizi, J.; Muyekho, F.; Mulaa, M.; Msangi, R.; Pallangyo, B.; Kawube, G.; Zziwa, E.; Mugerwa, S.; Ajanga, S.; Lukwago, G.; et al. 2015. Napier Grass Feed Resource: Production, Constraints and Implications For Smallholder Farmers in Eastern and Central Africa; The Eastern African Agricultural Productivity Project: Naivasha, Kenya,
8. Lekitoo, M. N., Kayadoe, M., Yoku, O., dan Djunaedi, M. 2020. Respon Produksi Rumput Gajah (*Pennisetum Purpureum*), Benggala (*Panicum Maximum*) dan Setaria (*Setaria Spacelata*) terhadap Perbedaan Salinitas. *Jurnal Riset Agribisnis dan Peternakan*, 5(1), 20-29.
9. Ressie, M. L., Mullik, M. L., dan Dato, T. D. 2018. Pengaruh pemupukan dan interval penyiraman terhadap pertumbuhan dan produksi rumput gajah odot (*Pennisetum purpureum cv Mott*). *Jurnal Sain Peternakan Indonesia*, 13(2), 182-188.
10. Haryani, H., Norlindawati, A. P., Norfadzrin, F., Aswanimiyuni, A., dan Azman, A. 2018. Yield and nutritive values of six Napier (*Pennisetum purpureum*) cultivars at different cutting age. *Malaysian J. Vet. Res*, 9, 6-12.
11. Negawo, A. T., Teshome, A., Kumar, A., Hanson, J., and Jones, C. S. (2017). Opportunities for Napier grass (*Pennisetum purpureum*) improvement using molecular genetics. *Agronomy*, 7(2), 28. doi:10.3390/agronomy7020028
12. Nugraha, Y. S., Sumarni, T., dan Soelistyono, R. (2014). Pengaruh interval waktu dan tingkat pemberian air terhadap pertumbuhan dan hasil tanaman kedelai (*Glycine max (L) Merril.*) (Doctoral dissertation, Brawijaya University).
13. Seseray, D. Y., Santoso, B., dan Lekitoo, M. N. 2013. Produksi Rumput Gajah (*Pennis etum purpureum*) yang Diberi Pupuk N, P dan K dengan Dosis 0, 50 dan 100% pada Devoliiasi Hari ke-45. *11(1)*, 49-55.
14. Zhou, S., J. Chen, Y. Lai, G. Yin, P. Chen, K.K. Pennerman, H. Yan, B. Wu, H. Zhang, X. Yi, C. Wang, M. Fu, X. Zhang, L. Huang, X. Ma, Y. Peng, Y. Yan, G. Nie, L. Liu. 2019. Integrative analysis of metabolome and transcriptome reveals anthocyanins biosynth

Cite this Article: Novitasari, A., Aprilia, R.M., Kusmartono, Subagiyo, I. (2025). Effect of Variability of Water Supply During 20 Days Before Harvest on the Morphological Characteristic of Red Elephant Grass (Pennisetum purpureum cv. Red). International Journal of Current Science Research and Review, 8(5), pp. 2350-2354. DOI: <https://doi.org/10.47191/ijcsrr/V8-i5-44>