# Production characteristics of red napier grass (*Pennisetum purpureum* cv. red) on different combination of soil and vermicompost as planting media

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**Abstract.** This study aimed at measuring production characteristics of Red Napier grass grown on planting media comprising different combinations of soil and vermicompost. The experiment was executed in greenhouse following completely randomized design with 5 treatments i.e. T0: 100% soil (control), T1: 75% soil + 25% vermicompost, T2: 50% soil + 50% vermicompost, T3: 25% soil + 75% vermicompost and T4: 100% vermicompost. Each treatment was replicated 5 times. The soil and vermicompost proportion were from 20 kg total planting media filled in polybags on which the grass stem cuttings were planted. Harvest was done 90 days after planting. Collected data were subjected to analysis of variance and least significant difference test. The results showed that treatments did not significantly affect ($P>0.05$) plant height, but significantly affect ($P<0.05$) leaf to stem ratio and very significantly affect ($P<0.01$) number of tillers, number of leaves, and nutrient production of stem, leaf and herbage. Highest production of dry matter was obtained at the treatment of T3.

## 1 Introduction

Forage is the main feed ingredient needed by livestock because it contains nutrients and minerals for growth, development and maintenance [1] Several types of forage that are widely cultivated are Bengal grass, King grass, Elephant grass and legumes. According to [2]. Elephant grass (*Pennisetum purpureum*) originating from Africa has great potential to be developed in Indonesia because it is well adapted to tropical climate and has the ability to grow quickly, produce high biomass and is palatable to ruminants. One of the cultivars that has not been widely studied in Indonesia is the Red Elephant grass (*Pennisetum purpureum*

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cv. Red). Limited information on the grass production characteristics such as number of tillers, number of leaves, leaf-stem ratio, dry matter production and nutritional content hinder the socialisation of this grass to be cultivated by farmers communities even though many seeds (cuttings) have been offered through e-commerce.

Production of Elephant grass is largely determined by soil fertility which contains nutrients and water for plants. Lack of nutrients can interfere with plant growth and thus require additional fertilisers. Fertilisation aims to improve soil nutrient availability to meet the plant needs. Fertilisers made of organic ingredients can improve the chemical and physical fertility of the soil [3]. Vermicompost is one type of organic fertiliser available at most farming communities.

Vermicompost is an organic fertiliser produced from the degradation of organic materials in earthworm cultivation media and worm droppings which contain macro and micro nutrients that can fertilise soil. According to [4], the vermicompost contained complete macro and micro nutrients that were easily absorbed by plants. It also contains growth regulators such as gibberellin, cytokinin and auxin, as well as the nutrients N, P, K, Mg and Ca and Azotobacter sp which are non-symbiotic N-fixing bacteria that help to increase N content so that it can increase plant production [5]. It was reported by [6]. that applying vermicompost fertilisers can increase the growth of green mustard plants. However, information about the use of this fertiliser for the production of forage crops, especially Red Elephant grass in Indonesia is still difficult to obtain. Therefore, this research was conducted to determine the production characteristics of the Red Elephant Grass (*Pennisetum purpureum* cv. Red) cultivated on different combinations of soil and vermicompost as planting media.

## 2 Materials and Methods

### 2.1 Location

The experiment was executed from April to August 2022, in a greenhouse at the Sumbersekar field station of the Faculty of Animal Science, Universitas Brawijaya in Malang Regency of Indonesia. It lies in a tropical humid zone, 112o34’35’’ East latitude and 7o55’07’’ South longitude, at ± 400 m as altitude. Nutrient contents of the harvested herbage biomass were analysed at the Animal Nutrition Laboratory Faculty of Animal Science Universitas Brawijaya. Soil nutrients were analysed at the soil Laboratory Faculty of Agriculture Universitas Brawijaya..

### 2.2 Research Variables

The variables measured were plant height, number of tillers/clump, number of leaves/clump, leaves to-stem ratio and nutrient production of the aerial biomass.

### 2.3 Research Procedure

Stem cuttings of the Red Elephant grass were obtained from a farm at Gadingkulon Village, Dau District, Malang Regency. The cuttings, comprising three internodes, were taken from healthy plants aged 2 to 3 months. The research followed a completely randomised design with 5 treatments of planting media i.e T0 = 100% soil, T1 = 75% soil + 25% vermicompost, T2 = 50% soil + 50% vermicompost , T3 = 25% soil + 75% vermicompost and T4 = 100% vermicompost. Each treatment was replicated 5 times. The soil and vermicompost proportion were from 20 kg total planting media filled in a polybag on which the grass stem cutting was planted. Assuming that the weight of soil per ha is 2000 tons so the proportion of 25%

vermicompost fertiliser at T1 is equivalent to 500 tons of vermicompost/ha, the 50% vermicompost fertiliser (T2) is equivalent to 1000 tons of vermicompost /ha and the proportion of 75% vermicompost fertiliser (T3) is equivalent to 1500 tons of vermicompost/ha. The soil nutrient content under different treatments is presented in Table 1.

**Table 1.** Nutrient content of the soil under different treatments

| Treatments | C-Organik (%) | N-Total (%) | Phosphor (%) | Kalium (cmol(+)Kg-1) |
|---|---|---|---|---|
| T0 | 1.52 (L) | 0.2 (L) | 62.0 (VG) | 3.69 (VG) |
| T1 | 6.16 (VG) | 0.57 (M) | 46.77 (VG) | 2.90 (VG) |
| T2 | 10.8 (VG) | 0.94 (VG) | 31.54 (VG) | 2.11 (VG) |
| T3 | 15.44 (VG) | 1.31 (VG) | 16.31 (G) | 1.31 (VG) |
| T4 | 20.08 (VG) | 1.68 (VG) | 1.081 (VL) | 0.52 (M) |

Note : VL = Very Low; L = Low; M = Moderate, G = Good; VG = very Good

The grass was harvested 90 days after planting. Plant height was measured just before the grass was harvested. After harvested, leaf blades and stems (including leaf sheaths) were separated and weighted. Composite samples of each plant part were taken and brought to the laboratory for Dry Matter (DM), Organic Matter (OM), Crude Protein (CP) and Crude Fibre (CF) analysis following the AOAC (2005) method. Leaf to stem ratio was measured as leaves DM production divided by stems DM production. Plant biomass production was measured by summing the leaves DM and stems DM production. Number of tillers was physically counted after harvest.

### 2.4 Statistical Analysis

The collected data were subjected to Analysis of Variance (ANOVA) using the formula

$$Yij = \mu + Ti + \varepsilon ij \quad (1)$$

where Yij = Observation of experiment j that received the treatment I, $\mu$ = overall mean, Ti = effect of treatment i and $\varepsilon ij$ = error effect in experiment j in the treatment i. If the ANOVA indicated a significant effect from treatments then the Least Significant Difference (LSD) test was applied to find differences between means.

## 3 Results and discussion

### 3.1 Characteristics and production dry matter

Production characteristics of Red Napier (*Pennisetum purpureum* cv. Red) including plant height, number of tillers, number of leaves, leaf-stem ratio and DM production of leaves and stems are presented in Table 2.

Data on Table 2 shows that treatments did not significantly ($P>0.05$) affect plant height. The average plant height between treatments was 133.72 ± 13.7 cm which is lower than the average plant height of Elephant grass (124 cm) reported by [7]. [8]. mentioned differences in plant height can be caused by cutting height, type of growing media, water supply and species differences.

**Table 2.** Characteristics and production variables of Red Napier under different treatments

| Variabel | Average at treatment: | | | | |
|---|---|---|---|---|---|
| | **T0** | **T1** | **T2** | **T3** | **T4** |
| Plant height (cm) | 117.8 ± 18.3 | 136.6 ±9.3 | 138.0 ± 13.5 | 140.8 ± 18.2 | 135.4 ± 9.1 |
| Number of Tillers/clump | $3.0^{a}$ ± 1.0 | $5.0^{a}$ ± 0.7 | $6.0^{a}$ ± 1.6 | $9.8^{b}$± 3.0 | $6.8^{ab}$ ± 2.1 |
| Number of Leaves /clump | $37.2^{a}$ ± 10.1 | $61.6^{a}$ ± 9.6 | $72.0^{ab}$ ±14.4 | $92.6^{b}$ ± 31.3 | $83.2^{ab}$ ± 7.6 |
| Leaf-Stem Ratio | $1.2^{b}$ ± 0.2 | $0.87^{a}$ ± 0.1 | $1.1^{ab}$ ± 0.1 | $0.9^{a}$± 0.2 | $0.9^{a}$ ± 0.2 |
| Leaves DM production (g/clump) | $9.3^{a}$ ± 1.6 | $23.89^{b}$±3.0 | $28.0^{b}$ ± 2.8 | $31.6^{bc}$ ± 3.2 | $23.3^{b}$ ± 3.1 |
| Stem DM production (g/clump) | $8.0^{a}$± 0.7 | $27.39^{b}$±2.1 | $26.4^{b}$ ± 5.8 | $34.4^{b}$ ± 7.5 | $27.1^{b}$ ± 2.4 |

Note : Different superscripts on same line indicate significant differences ($P<0.05$) [1]Data

Number of tillers/clumps as an indicator of ability for grass regrowth[9, 10] were significantly ($P<0.05$) different between treatments. It was highest (9.8 per clump) at T3 and lowest (3.0 per clump) was at T0. Similarly, the number of leaves/clumps was also significantly ($P<0.05$) affected by treatments and the highest (92.6 per clump) was found under the T3 treatment. The highest number of tillers/clump and leaves/clump occurred at the highest content of C-total and N-total with good levels of P and K in the T3 treatment planting media as shown in Table 1. Sufficient nitrogen and phosphor elements in the planting media will increase protein synthesis which is utilised by plants for meristematic cell division and enlargement forming of more tillers and leaves [11].

Table 2 shows that the leaves and stems DM production as well as leaves to stems ratio was significantly ($P<0.05$) affected by treatments. Highest leaves to stems ratio (1.2) was found at the T0 treatment. This was similar to the finding of [7] i.e. leaves-stem ratio of 1.2 for Elephant grass harvested at 90 days of age but lower than the leaves to stems ratio of dwarf Elephant grass reported by [12, 13]. However, data in Table 2 also shows that production of either leaves or stems DM at T0 treatments were significantly ($P<0.05$) lower than that obtained at the other treatments. Although statistically insignificant compared to those under T1, T2 or T4 treatments, the numerical value of average production of leaves or stems DM of T3 treatments were found to be the highest i.e. 31.6 ± 3.2 and 34.4 ± 7.5 g/clump those gave a leaves to stem ratio of 0.9 ± 0.2.[14] stated the high number of grass leaves indicate the potential of forage for animal feed. In this experiment, however, the highest leaves to stems ratio at T0 treatments coincided with lowest leaves and stems DM production. The T3 treatment, even though it gives lower leaves to stem ratio, produces higher leaves and stem DM biomass. This T3 treatment, as already mentioned above, also gives the highest number of tiller/clump and number of leaves/clump.

### 3.2 Nutrient Production

Analysis of variance found that treatments significantly (P<0.05) affect the DM, OM, CP and CF production. Data of plant parts production between treatments are presented in Table 3.

**Table 3.** Production of nutrients of the Red Napier plant parts between treatments

| Nutrient | Plant Parts | Production (g/clump) at treatment: | | | | |
|---|---|---|---|---|---|---|
| | | T0 | T1 | T2 | T3 | T4 |
| DM | Plant | $17.3^{a} \pm 2.2$ | $51.3^{c} \pm 5.0$ | $54.5^{c} \pm 8.4$ | $65.9^{d} \pm 8.4$ | $42.1^{b} \pm 6.3$ |
| | Stem | $8.0^{a} \pm 0.7$ | $27.4^{b} \pm 2.1$ | $26.4^{b} \pm 5.8$ | $34.4^{c} \pm 7.6$ | $27.1^{b} \pm 2.4$ |
| | Leaves | $9.3^{a} \pm 1.6$ | $23.9^{c} \pm 2.9$ | $28.1^{d} \pm 2.8$ | $31.6^{d} \pm 3.2$ | $14.9^{b} \pm 3.9$ |
| OM | Plant | $15.4^{a} \pm 2.0$ | $46.7^{b} \pm 4.5$ | $50.2^{bc} \pm 7.8$ | $61.9^{d} \pm 7.9$ | $39.8^{b} \pm 5.9$ |
| | Stem | $7.4^{a} \pm 0.7$ | $24.8^{b} \pm 1.9$ | $24.1^{b} \pm 5.3$ | $32.1^{c} \pm 7.1$ | $25.6^{b} \pm 2.3$ |
| | Leaves | $8.1^{a} \pm 1.4$ | $21.8^{c} \pm 2.7$ | $26^{d} \pm 2.6$ | $29.8^{e} \pm 2.9$ | $14^{b} \pm 3.7$ |
| CP | Plant | $0.7^{a} \pm 0.1$ | $2.5^{b} \pm 0.2$ | $3.3^{c} \pm 0.5$ | $4.3^{d} \pm 0.6$ | $3.1^{c} \pm 0.5$ |
| | Stem | $0.2^{a} \pm 0.1$ | $0.9^{b} \pm 0.1$ | $1.1^{b} \pm 0.2$ | $1.7^{c} \pm 0.4$ | $1.7^{c} \pm 0.2$ |
| | Leaves | $0.5^{a} \pm 0.1$ | $1.6^{b} \pm 0.2$ | $2.2^{c} \pm 0.2$ | $2.6^{d} \pm 0.3$ | $1.3^{b} \pm 0.3$ |
| CF | Plant | $6.2^{a} \pm 0.8$ | $16.7^{c} \pm 1.6$ | $17.2^{c} \pm 2.7$ | $20.4^{d} \pm 2.6$ | $12.5^{c} \pm 1.9$ |
| | Stem | $3.1^{a} \pm 0.3$ | $9.1^{bd} \pm 0.7$ | $8.5^{b} \pm 1.9$ | $10.9^{d} \pm 2.4$ | $8.3^{b} \pm 0.7$ |
| | Leaves | $3.2^{a} \pm 0.6$ | $7.6^{b} \pm 0.9$ | $8.7^{bc} \pm 0.9$ | $9.6^{c} \pm 1.0$ | $4.3^{a} \pm 1.2$ |

Note : Different superscripts on the same line is significantly different (P<0.01)

Table 3 shows that the highest production of DM of each plant part is found at the T3 treatment. At this treatment, production of either leaves or stems DM is highest as already discussed in section 2.2. while the DM production of plant, as shown in Table 3, is also highest at T3 that reached 65.96 ± 8.37 g/clump. In line to this, highest production of OM, CP and CF also occurred under the T3 treatment. At this treatment, the planting media contained highest C-total and N-total with good levels of P and K and hence was able to provide nutrients as needed by the grass to optimise production. [15] mentioned that 80% of plant dry weight comes from carbon and nutrients supplied by organic fertilisers. The vermicompost application at T3 also provides relatively high phosphorus and nitrogenous nutrients to planting media. Availability of these two nutrients may play a role in the formation of Adenosine Triphosphate (ATP) which will function as an energy source and or nitrogenous compounds that contribute to cell division and growth that eventually increase DM and OM production of all components of the Red Napier grass. [16]. mentioned that nitrogen plays a role in forming chlorophyll needed for photosynthesis to produce assimilates such as protein and carbohydrate. In overall, the increased amount of DM produced under the T3 treatment was followed by higher production of other nutrients such as CP and CF.

## 4 Conclusion

On the basis of results and discussions above it could be concluded that the use of vermicompost up to 75% of total soil for growing Red Napier grass will lead to high number of tillers and leaves as well as highest amount of DM, OM, CP and CF production of the grass biomass.

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